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Letters to the Editor

THE OPTICS OF MIRAGES

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1. INTRODUCTION

IN describing and interpreting our visual impressions, it is natural to adopt the geometric approach provided by ray-optics, since this is the most familiar and therefore the most easily understood approach. But this does not mean and it would indeed be incorrect to assume that even the most familiar optical effects which we can perceive with the unaided vision can always be explained on the basis of the ideas of geometrical optics. The propagation of light in various circumstances needs in general the concepts of the wave-theory for its correct and complete elucidation. Only in the particular case of a set of waves of constant type and the rays associated with them are the wave-optical and ray-optical descriptions completely equivalent.

The foregoing remarks have a bearing on the phenomena of atmospheric optics, in other words of the effects noticed when distant sources of light are viewed through great depths of air. The atmosphere of the earth is an inhomogeneous medium and though the refractivity and its variations are both small, this is set off by the very long optical paths often involved. Hence, the deformations of the wave-fronts in their passage from the light-source to the observer are by no means negligible and in particular circumstances, their consequences may be very conspicuous. The familiar phenomenon of the twinkling of the stars may be cited as an example. In the case of terrestrial objects, we are concerned with the lower levels of the atmosphere where the refractivity is a maximum and also liable to large variations by reason of a variety of circumstances. Hence, a variety of effects may arise which are readily observable. As remarked above, it would not be correct to assume that these effects can all be understood or explained on the basis of the ideas of geometrical optics. It is, on the other hand, to be anticipated that the aid of the wave-theory would be needed for the purpose.

2. THE ORIGIN OF MIRAGES

Mirages constitute a remarkable group of effects arising from variations of the refractive index of the atmosphere. They are generally described as of two kinds, being respectively the so-called superior and inferior types of mirage. The latter are quite common and may be described as the manifestation above the level heated surface of the earth of a reflection of the sky and other elevated objects : the latter appear as inverted images against the background of the reflected sky and thus simulate the reflection of terrestrial objects at the surface of a pool or lake. The superior type of mirage arises when the thermal conditions of the atmosphere are the reverse of those which give rise to mirages of the inferior type ; they are observed when the atmosphere rests on a cold level surface above which there lies a hot stratum of air. Objects at or near the level of the cold surface are usually visible to the observer, and in addition inverted images of them are also seen higher up in the atmosphere. Pictures of both types of mirage are to be found reproduced in many treatises on optics and meteorology. A famous example of the superior type of mirage in which objects thus seen reflected were ships at sea was that described and figured by Vince in the year 1799. His drawings are reproduced or referred to in many accounts of the subject. We shall have occasion to refer to them again later in this article.

3. MIRAGES AND RAY-OPTICS

The theory of mirages usually accepted purports to base itself on geometrical optics. This explanation is said to have been first put forward by Monge, but it was later elaborated and discussed by many other authors. The interested reader will find a very full review of the literature covering 80 pages in the Second Edition (1922) of Pernter's treatise on meteorological optics as revised by Exner. The explanations usually given are illustrated by drawings which show the curved path of the rays from the source which reach the observer and are perceived by him as a reflected image of the source. These drawings seem very plausible, but when one examines them with care, it becomes evident that the explanations put forward do not really come to grips with the problem and may indeed be described as a kind of make-believe. That a geometric theory is fundamentally incapable of explaining the phenomenon of the mirage becomes clear on a critical examination of the subject.

The circumstances in which mirages are observed bear a superficial resemblance to those in which the familiar phenomenon of total reflection occurs, *viz.*, light travelling in

a medium of higher refractive index meets a medium of lower index at an incidence exceeding the critical angle and is then turned back. There is, however, a fundamental difference between the problem of the mirage and the circumstances of total reflection referred to above. We do not have in the atmosphere anything in the nature of a discontinuous change of refractive index; what we are actually concerned with is a progressive change of index. In the latter circumstances, a pencil of rays travelling obliquely through the stratified medium would, according to Snell's law of refraction, be progressively deviated until it reaches a layer at which its course becomes tangential to the plane of the stratifications; thereafter, it would continue on a course parallel to the stratifications. No question of total reflection can therefore arise.

4. Mirages and Wave-Optics

If it be assumed that the wave-optical and ray-optical descriptions of the behaviour of light are completely equivalent, it would follow that the rays and wave-fronts in an isotropic but inhomogeneous medium are everywhere normal to each other. Accordingly, if the course of the rays is known, the wave-fronts form a set of surfaces cutting them orthogonally. It was stated above as a consequence of Snell's law of refraction that a ray of light initially making an angle with the plane of the stratifications would be progressively deviated from its course until it becomes tangential to that plane and would then continue on a course parallel to the stratifications. This would happen to every one of the rays of an incident beam of light. Accordingly, if we take two adjacent rays at a finite distance apart, the part of the wave-front between them would swing round and at the same time contract in its extension and ultimately become a point which moves parallel to the stratifications in a plane whose position can be specified exactly for the particular circumstances of the case.

An approach to the problem of the mirage based on the ideas of geometrical optics thus leads us to conclude that the energy of the incident radiation would be concentrated at a limiting plane which it reaches but is unable to penetrate. The intensity of illumination in that plane would therefore be infinite. Since such a result is physically inadmissible, it follows that the approach which leads to it should be given up in favour of a different and more rigorous treatment based on the first principles of the wave-theory.

5. The Analytical Theory and Its Results

To make the problem tractable, it has to be idealised to some extent. We consider the optical behaviour of a slab of the medium which is assumed to be of finite thickness and bounded by plane parallel faces extending to infinity. The material is also assumed to be stratified in planes parallel to its faces, the refractive index being μ_1 at the front surface and μ_2 at the rear, μ_1 being greater than μ_2. Plane waves of light are assumed to be incident on the slab at a glancing angle ϕ_1. It is clear that if $\mu_1 \cos\phi_1$ is greater than μ_2, the incident waves cannot emerge from the rear face of the slab. We are interested in ascertaining the nature of the disturbance both within the slab and in front of it in the circumstances stated.

The solution of the problem is contained in a paper by S. Pancharatnam and the present author published in the *Proceedings of the Indian Academy of Sciences* for May 1959. We must be content here with a brief statement of the results. The paper quoted also contains a full account of the results of experimental studies on the subject. This will be drawn upon very freely in the latter half of the present article. It should be mentioned that the experiments, besides confirming the results of the analysis have also revealed other unsuspected features which assist in the elucidation of the phenomena actually noticed in mirages on a large scale in the open-air. The illustrations accompanying the present article, Figs. 1, 2 and 3 are also taken from the paper under reference.

Briefly stated, the analysis indicates that when $\mu_1 \cos\phi_1$ is greater than μ_2, the light incident on the front face of the slab is returned from its interior with full intensity and in a direction justifying its description as a regularly reflected disturbance. The analysis also shows that within the slab, the intensity of illumination attains a large value in the vicinity of the limiting plane at which the refractive index μ_L has the value $\mu_1 \cos\phi_1$. The intensity falls off rapidly to small values in the rear of that plane, while in front of it, the intensity diminishes gradually at the same time exhibiting a series of maxima and minima of which the separation falls off progressively, finally approaching a constant value.

The situation described above closely resembles the effects well known to all students of optics which are observed in the vicinity of *caustics*. Accordingly, we may in the present case state that the incident and reflected

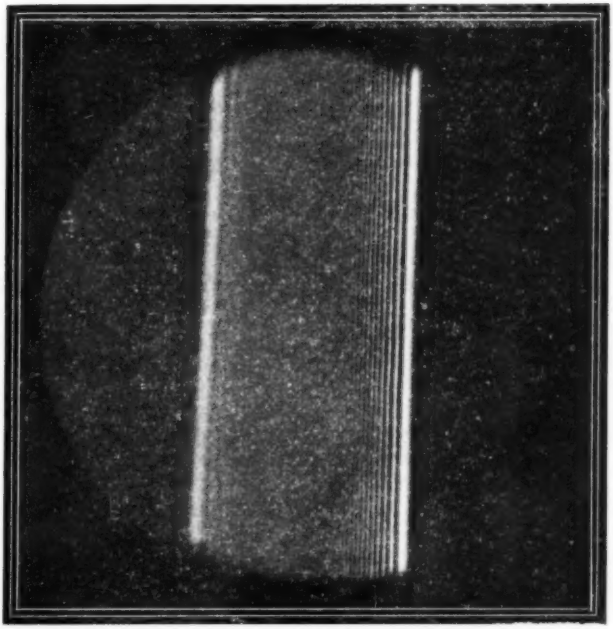

FIG. 1

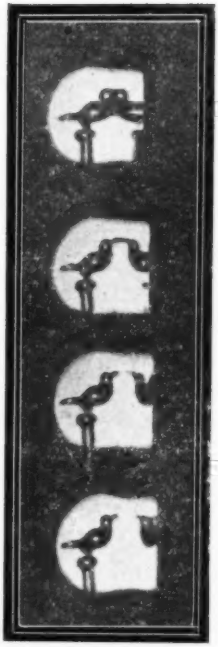

FIG. 2

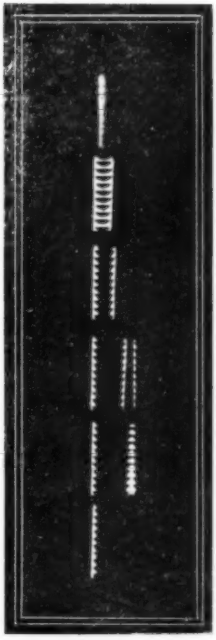

FIG. 3

disturbances join up and form a cusped wave-front; the cusp rests upon the limiting plane referred to above and the entire wave-front moves along that plane in a direction parallel to the plane of incidence. At and near the cusp, the two branches of the wave-front are sensibly parallel to each other, besides being normal to the plane of the stratifications. Further out, however, they separate and diverge, ultimately becoming normal to the incident and reflected rays in the sense of geometric optics. The progressive diminution in the spacing of the successive maxima of illumination is readily understood on this basis.

6. Observation of the Caustic and Accompanying Interferences

Mirages can be produced and observed on a small scale in the laboratory as has been shown by R. W. Wood and others. In the arrangements generally used, the hot plate above which the mirages are observed is held horizontally. Though in some respects this arrangement is very convenient, it is not useful for critical studies owing to the thermal instability of the air above a heated plate. This difficulty is minimised by holding the heated plate edgewise so that its surface is vertical while the length remains horizontal. The object studied is an illuminated slit kept at some distance from the heated plate parallel to its surface. The light diverging from the slit is rendered parallel by a collimating lens and then allowed to fall obliquely on the heated plate. The beam is allowed to cover the whole length of the plate, the angle of incidence being adjustable by a lateral movement of the illuminated slit.

Photographs of the field of illumination in the rear of the hot plate could be secured with these arrangements and with very short exposures, provided that sunlight is used to illuminate the slit. With such short exposures the effects of thermal instability are eliminated completely. A typical example of a photograph thus obtained is reproduced in Fig. 1 accompanying. The use of a red filter to monochromatise the light greatly improves the results obtained. It will be seen that the features indicated by the theory and other features as well are very clearly exhibited.

The field of illumination appearing in Fig. 1 consists of three parts. To the right of the bright caustic (i.e., towards the heated surface) the field is dark, while to its left lies an illumined strip containing a large number of interference fringes whose separation narrows down to a constant value as we move away from the caustic; since the heated plate is necessarily of finite extension, the reflected part of the cusped wave-front does not extend to infinity but is terminated. This manifests itself in the field of view by the occurrence of a second edge to the left of which the intensity is considerably less (though not zero), the edge being bordered by some broad fringes.

7. Relation of the Mirage to the Cusped Wave-Front

The actual mirage is observed when the eye is kept at any point which lies on the bright strip of light lying to the left of the caustic, the eye being focussed on the plane containing the object, *i.e.*, at infinity. It is to be expected that two images would then be seen whose positions lie respectively along the directions of the normals drawn from the eye to the two branches of the cusped wave-front leaving the nearer edge of the plate. In fact, the fringes observed to the left of the caustic in Fig. 1 may be regarded as due to the interference between the light from two such virtual sources, the progressive narrowing of the spacing of the fringes to the left of the caustic corresponding to the increasing separation of the sources. That the separation of the two images observed depends on the position of the eye or aperture through which the phenomenon is viewed is illustrated in Fig. 3. In order to make the nature of the image evident, the serrated edge of a hacksaw blade has been used to form one of the edges of the slit. An aperture was kept before the camera lens and the succession of photographs exhibit the alteration in the phenomena as the aperture is gradually moved to the left. When the aperture is on the bright caustic, a single image is seen, while as it is moved to the left this separates into two images, one of which is a direct (or more properly, a refracted) image, the second being an inverted reflected image, the separation between the two gradually increasing. A remarkable feature of the sequence of phenomena illustrated in Fig. 3 is the occurrence of a third erect image close to the reflected image in the fourth and fifth photographs of the sequence; this image starts developing when the aperture has been moved towards the outer edge of the central illumined strip (where broad fringes start appearing in Fig. 1) and becomes coincident with the reflected image when the aperture is exactly at the edge mentioned. As the aperture is moved further left, only the 'direct' image continues to be visible, as is shown in the last photograph of the sequence; this is to be expected since the reflected part of the cusped

wave-front is no longer received through the aperture.

The third image mentioned above could be cut off by inserting an opaque screen near the farther end of the heated plate and adjusting it so that its edge protrudes a little beyond the surface of the plate. This shows that the image is due to the ordinary refraction of rays directly entering the edge of the heated layer at the farther end of the plate. The main features of the path of such rays may be deduced from the experimental observations described in the previous paragraph. The terminus of the reflected part of the cusped wave-front corresponds to certain limiting rays entering the region at the farther end of the plate. Rays which are able to enter the edge of the heated layer at a closer distance to the plate than these limiting rays proceed a longer distance before emerging from the heated stratum and also suffer a larger deviation. These rays give rise to the erect third image ; in fact, the second refracted wave-front, obtained by drawing the surfaces orthogonal to these rays, meets the termination of the refracted part of the wave-front so as to form a second cusp.

Till now we have dealt mainly with the case when the distant object is of negligible angular dimensions. When an object of finite angular dimensions is used, the point on the image which corresponds to any particular point on the object is to be determined as before for each setting of the eye. In this case there will be a distortion of the images because the position of the limiting layer as well as the inclinations of the cusped wave-fronts corresponding to any particular point on the object varies with the position of the object-point. Figure 2 shows the photographs taken using as the object a small model of a bird made of glass. This was placed near the focal point of the collimating lens. The sequence of photographs show the variation in the appearance of the phenomena as the eye is moved away from the plane of the plate. The appearance of a third erect image in addition to the usual reflected image may be discerned in the last two photographs of the sequence. It is worthy of note that a third erect image adjoining the inverted image which is the principal feature of the mirage has actually been noticed by various observers in mirages as seen in a large scale in the open air. It was noticed, for example, by Hiller in his study of mirages of the inferior type produced by a long vertical wall which had been warmed by the sun's rays. Hiller's photograph showing this effect is reproduced in Pernter's treatise already mentioned and also elsewhere. The third erect image is a conspicuous feature in Vince's drawings of ships at sea exhibiting the phenomenon of the superior mirage. It may safely be presumed that the explanation of its appearance is analogous to that of the effect noticed in the laboratory experiments and illustrated in Figs. 2 and 3 above.

COMMONWEALTH EDUCATION CONFERENCE

THE report of the Commonwealth Education Conference, presented at the final session at Oxford on July 28, 1959, adds an important chapter to the history of Commonwealth endeavour and co-operation.

The Conference has helped to carry a step forward the scholarship scheme originated by Canada and approved last year at Montreal. As a result not only will the scheme come into force in the year 1960-61 but the target of 1,000 scholarships may well be exceeded. Of these United Kingdom has offered to provide 500 and Canada 250. In the main the Commonwealth Scholarships will be for post-graduate study or research. A limited number of awards will be made to senior scholars of established reputation and achievement and called Commonwealth Visiting Fellowships.

The report points out that over the first five years Commonwealth Governments will spend at least £10,000,000 in addition to their present expenditure, on education.

One of the major problems to be solved is about the acute shortage of trained teachers. While the long-term problem of Teacher Training needs must be solved by the respective countries themselves, the report shows that a number of practical suggestions have been made at the Conference to meet the immediate needs.

On the supply of teachers the report estimates that 500 teachers are wanted immediately for training institutions, well over 1,000 a year for secondary schools, and 200 a year for technical schools. Universities also need staff, often in highly specialized subjects. In this respect the attention of Governments is being drawn to the need for satisfactory arrangements for the reception and welfare of the scholars and teachers on which much of the success of the plan will depend.

The report suggests that funds are to be allocated for teaching English as a second language, and a group of Commonwealth experts will shortly consider the problems involved in teaching this subject.

STRUCTURE OF POLIO VIRUS AS REVEALED BY X-RAYS

X-RAY analysis of crystals of poliomyelitis virus by Dr. A. Klug and Mr. J. T. Finch of Birkbeck College, London, has thrown new light on the basic structure of the virus. The virus particle has been shown to have the geometrical symmetry of the figure known as an *icosahedron* (a closed shape with twenty plane faces).

Poliomyelitis virus, which is one of the smallest viruses, is shown by electron microscope to be a spherical particle about 3 mμ in diameter. Chemical studies have shown that small viruses consist of protein molecules and RNA (ribonucleic acid), which in living cells is believed to be responsible for the synthesis of proteins. Scientific interest was focussed on virus structure more than two decades ago when it was found that some of the viruses which cause plant diseases could be prepared in a crystalline form, and as such X-ray techniques could be used for studying their structure.

The first fruitful application of X-ray analysis of virus structure was in the case of the tobacco mosaic virus (TMV). Here X-ray studies revealed that the rod-shaped virus, about 2 mμ in diameter and 30 mμ in length, had a helical structure which arises from the regular arrangement of identical protein units in the form of a screw thread (as yet unknown whether left or right handed) and leaving a narrow axial hole about 0·3 mμ in diameter. Further it was shown that the RNA content of the virus was located some 0·4 mμ from the central axis most probably arranged as a single strand of the long continuous "backbone" of the molecule sandwiched in helical form between the successive turns of the outer protein helix. In the intact molecule it is inferred that this arrangement of the RNA confers some degree of stability to the protein sheath of the virus, presumably because it is bound to the units of the sheath by chemical or other forces.

Poliomyelitis viruses are considerably more difficult to handle and so far the picture of their structure which has been built up is not as nearly complete as that of TMV. From the new investigations of Klug and Finch it has been possible to conclude that the virus is built up of sixty identical units arranged and held together in such a way that they form a shape with the correct icosahedron symmetry (Fig. 1). The icosahedron, which is one of the five regular polyhedra, can be pictured as two regular pentagonal pyramids with their pentagon bases separated parallel to each other and twisted, so that the sides of the one are opposite the vertices of the other. The ten points of the two pentagons when joined will form ten equilateral triangles alternately upright and inverted, girdling the two pyramids. With the five faces of each of the two pyramids there will thus be twenty triangular plane faces in the icosahedron.

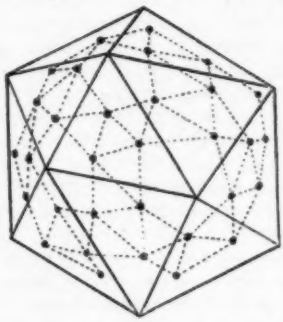

FIG. 1. An icosahedron drawn round a diagram of a polio virus. Each dot represents a protein unit and is related to the icosahedron in a symmetrical way.

The suggestion has been put forward that the sixty units are protein molecules. These units are arranged to form a roughly spherical shell in which each unit will be surrounded by either four or five immediate neighbours. (The second arrangement is the more probable.)

This is the first time that the detailed internal structure of an animal virus has been elucidated. The poliomyelitis virus has a structure which is similar to several of the small plant viruses (turnip yellow virus and bushy stunt virus for example) which also have been shown by X-ray analysis to consist of spherical shells with icosahedral symmetry. It is now becoming clear that geometry plays an important part in virus structure. The reason for the particular geometry displayed by the spherical viruses is probably that this icosahedral arrangement is the most economical way of "packing" the small protein units round a central core.

In its way this structure of the poliomyelitis virus is similar to that of TMV. There is a sheath of protein surrounding or containing RNA in some position as yet unidentified. The protein, as in TMV, is made up of a number of identical units which are held together in strict geometrical regularity. These structural inferences are of importance in understanding such fundamental problems as how viruses live and reproduce themselves and how they may sometimes destroy living biological cells.

THE CARNEGIE INSTITUTION*

THE work of the Institution during the year July 1, 1957-June 30, 1958, is reviewed by the President, Caryl P. Haskins, in the first 45 pages of the book. This is followed by detailed reports of current research and special studies from the seven Departments of the Institution, *viz.*, Mount Wilson and Palomar Observatories (pp. 49-92), Department of Terrestrial Magnetism (pp. 93-166), Geophysics (pp. 167-260), Plant Biology (pp. 261-305), Embryology (pp. 306-72), Genetics (pp. 372-431) and Archæology (pp. 432-57).

The year under report marks the tenth anniversary of the dedication of the 200-inch Hale telescope on Mount Palomar (June 3, 1948) and also of the agreement of the joint operation of the Mount Wilson and Palomar Observatories by the Carnegie Institution (April, 1948). Hence appropriately enough the report from the Observatories Department reviews the observational programs carried out during the first decade of this joint operation. The connected accounts of Solar observations, Stellar spectroscopy, Gaseous nebulæ, Galactic cluster and Galaxies provide instructive reading. As is known there is a guest-investigator program under the joint operation of the Mount Wilson and Palomar Observatories. The purpose of this is to make the unique facilities of the Observatories available, whenever possible, to a wider group of astronomers from other institutions and countries. The report says that under this program during the decade 60 astronomers from 23 institutions in U.S. made 160 visits, and 20 astronomers from 12 other countries made 26 visits.

In the Department of Terrestrial Magnetism wide areas for research have been selected ranging from the study of cosmos and interstellar space to that of living cells. The Department has continued its active programs in radio astronomy, study of solar features by the 88 cm. wavelength (340 Mc.) and cosmic ray investigations with special reference to solar activities. The International Geophysical Year has naturally given a great impetus to the activities of this Department as well as of the Geophysical Laboratory. They participated in three IGY projects, all of them being further extensions of interests already developed in the Departments. The first of these projects concerned the study of the intense band of electric current, called the "electrojet", that circulates in the upper atmosphere in the region of the earth's magnetic equator. The second is the study of the earth's crust at the high plateau of the Andes, making use of explosions normally set off in the operation of large open-pit copper mines, and observing the waves produced by them. The third is the measurement of the ages of rock minerals by radioisotopes.

The Geophysical Laboratory has brought into full operation a high-pressure apparatus for phase-equilibrium investigations up to 50,000 atmospheres at 1,700° C. simultaneously. Data on the change in melting point of various silicates with pressure, obtained with the apparatus, will help estimating the geothermal gradient within the mantle. The report shows that investigations in experimental petrology have made active progress. During the year Willard F. Libby has carried on a series of researches on geochemistry of fission products, particularly strontium 90. It is a pity that the rock magnetism work was discontinued during the year on account of Dr. John Graham, who was responsible for more than a decade of intensive work in this field, having left the Institution.

In the Department of Plant Biology the nature and mode of action of chlorophyll as it occurs in living plants, as contrasted with the properties of isolated chlorophyll, have continued to be the major interests. Investigations on the absorption spectra of chlorophylls in various algæ and chlorophyll synthesis *in vivo* and *in vitro* find a prominent place in the report. In the Department of Embryology progress in the field of immunoembryology has been of main interest and the article "The acquisition of biological specificity" presented by the Director James D. Ebert deserves mention. The focal point of the research program of the Department of Genetics continues to be the study of structure and properties of genes and chromosomes. Few aspects of modern research are more challenging than those of theoretical biology. The Carnegie Institution is deeply concerned with this frontier. Five of the seven departments include in their programs investigations in the life sciences.

The year under report also marks the termination of the work of the Department of Archæology bringing to a close a record of pioneering achievement in the directed research of the history of the Maya civilization in Middle America, started by Sylvanus G. Morley 45 years ago. In the final report of the Department presented in the Year Book, the past activities of Carnegie Institution in anthropology and archæology has been reviewed.

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* *Carnegie Institution of Washington—Year-Book* 57. Pp. xi + 497. Price $ 1.00 (1530, P Street, Northwest, Washington 5, D.C.).

APPLICATIONS OF ELECTROPHORESIS TECHNIQUE IN FORENSIC SCIENCE

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THE forensic scientist is frequently called upon to detect and estimate traces of drugs and poisons of animal, plant or synthetic origin in a great variety of biological material. A large number of tests are published in scientific literature for the detection and estimation of many substances. Most of these chemical and biological tests are non-specific and hence they are of little use when employed directly on the material. It is, therefore, necessary to employ techniques which will resolve complex mixtures into individual components on which the chemical and biological tests can be safely applied to express a correct and definite opinion. Moreover, the quantity of material available for such examination is usually very small. Techniques of electrophoresis and paper chromatography discovered by Tiselius,[1] and Martin and Synge[2] respectively are invaluable tools in a forensic science laboratory for the separation of individual components in complex mixtures, particularly when the quantity available is very small. It is proposed to deal with the technique of electrophoresis and its applications in this paper.

Tiselius used boundary electrophoresis as a means of separating the protein components of plasma as early as 1937. A large number of workers have modified and used this technique in the analysis of complex protein mixtures and other compounds capable of possessing a charge in an aqueous buffer.

The apparatus necessary for boundary electrophoresis is complex and expensive. Hence paper electrophoresis, which is a very simple technique, first employed by Wieland and Fischer,[3] in 1949, has been extensively used in recent years for the separation of gonadotrophin in urine,[4] Thyroglobulin in serum,[5] muscle extracts,[6] Isoaglutinins[7] and other materials. Mackay[8] and Cooper[9] have carried out the analysis of human serum by this technique. It is not necessary to describe the electrophoresis apparatus and the experimental procedure as they are generally well-known and are in use in many laboratories in India.

The curves are obtained by scanning the papers with a suitable Densitometer. The areas under the Densitometer curves are measured with a Planimeter and the amount of each component is expressed as a percentage of the total area. This percentage will be proportional to the amount of protein provided the technique is standardized very carefully.

This technique has been employed to study the electrophoretic patterns of the blood sera from the different species. The data obtained by Mickinlay and Farmilo[10] for the sera of Horse, Rat, Dog, Sheep, Buffalo, Rabbit, Cow, Pig and Guineapig are given in Tables I and II. If a number of sera are separated on the same sheet of paper it would be possible to obtain a direct comparison under identical conditions. The individual pattern for these species is quite characteristic. The albumin fraction of most species moved at about the same rate in most instances but the albumin fraction of Dog sera was always more mobile than that of any other species studied. The albumin fraction of Guineapig and Rat sera moved at slower rates than the albumin from other species. The data presented here indicate that there are considerable

TABLE I

	Albumin	Globulines								
		α_1	α_2	α_3	β	β_1	β_2	γ	γ_1	γ_2
Horse ..	44·84	2·34	8·13	..	11·89	..	..	34·74	..	..
Rat ..	46·10	4·52	10·83	..	20·15	..	..	18·41	..	..
Dog ..	51·41	4·52	4·52	5·02	..	6·17	18·41	..	..	9·95
Sheep ..	37·40	2·29	3·16	4·36	..	7·27	9·22	..	36·30	..
Buffalo ..	32·35	..	26·03	..	8·48	..	..	33·14	..	..
Rabbit ..	52·30	3·66	9·12	3·98	..	13·10	3·34	14·5	..	..
Cow ..	46·50	..	13·60	..	..	9·30	..	..	17·80	12·80
Pig ..	31·60	2·06	16·82	9·05	..	..	17·00	..	..	23·47
Guineapig ..	58·58	4·11	11·46	..	11·46	..	..	14·39	..	..

TABLE II

Relative mobilities of serum protein components expressed as a fraction of the distance moved by the albumin of the same serum

	Albumin	α_1	α_2	α_3	β_1	β_2	γ_1	γ_2
Horse ..	1·00	0·79	0·66	..	..	0·47	0·23	0·05
Rat ..	1·00	0·80	..	0·65	..	0·40	..	0·06
Dog ..	1·00	0·90	0·78	0·08	0·56	..	0·34	0·09
Sheep ..	1·00	0·84	0·76	0·62	0·49	..	0·34	0·20
Buffalo ..	1·00	..	0·74	..	0·54	..	0·23	..
Rabbit ..	1·00	0·85	0·73	0·65	0·56	0·47	0·21	..
Cow ..	1·00	0·86	0·72	..	0·51	..	0·36	0·13
Pig ..	1·00	0·87	0·63	..	..	0·39	..	0·11
Guineapig ..	1·00	0·85	0·68	..	..	0·39	..	0·11

differences in the electrophoretic patterns of sera from different species of animals and this technique can be used for characterising animals of different species. Connel[11] has demonstrated that the muscle extract from 20 different species of fish gave characteristic electrophoretic patterns. From the medico-legal point of view this technique can be applied for the identification of the species from a blood stain which should be extracted with normal saline before running the electrophoresis.

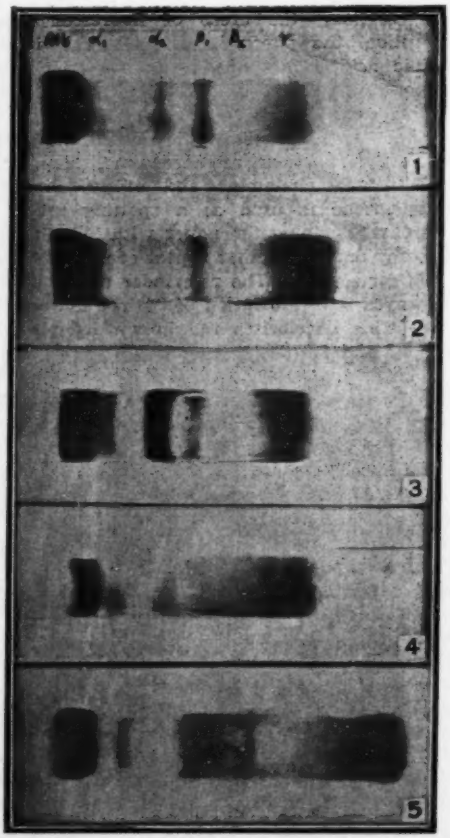

FIG. 1. (1) Normal serum. (2) Cirrhosis. (3) Pulmonary Tuberculosis. (4) Nephritis. (5) Cancer (Stomach).

In recent years, this technique has been used extensively for diagnostic purposes in pathological laboratories attached to hospitals. The characteristic electrophoretic patterns for a number of specific diseases have been worked out by Giri[12] and these have been reproduced in Fig. 1. If a suspect involved in a criminal case happens to be suffering from a particular disease resulting in a characteristic electrophoretic pattern of the blood, it may be possible in rare cases to state that the blood found at the scene of the crime belongs to that particular individual, if there is other circumstantial evidence in favour of this hypothesis.

In order to control the International Drug Traffic, the geographical region of opium in the illicit trade must be known so that the supplies of the drug may be cut off at the source. To this end, the Economic and Social Council of the United Nations in 1948-49 authorised research into devising chemical methods of identifying opium and invited member Governments to participate in such a programme and to provide authentic samples for opium research. The technique of paper electrophoresis has been applied for the detection of the country of origin of opium. Opium samples from different countries were ground in a mortar in 10% acetic acid and filtered. A portion of the clear filtrate was applied to the paper and electrophoresis was carried out in the usual manner. A phosphate citrate buffer at a pH of 5 was used. The alkaloids move to the cathode at this pH and a separation into

several fractions is accomplished in a 24-hour run using a potential of 200 volts and a current of 2 m.a., per inch width of paper. The papers were removed, air-dried and photographed under mercury arc ultraviolet light. A photograph of an electropherogram showing the patterns of opium from several different countries of origin are shown in Fig. 2.

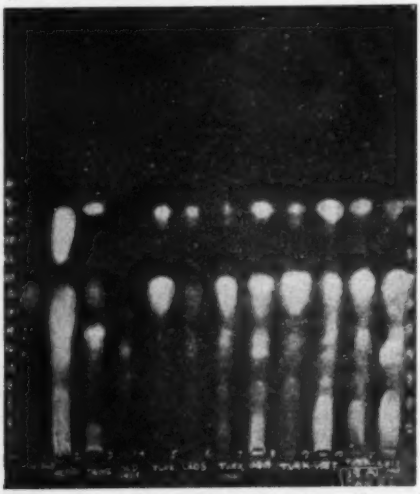

FIG. 2. Shows] electrophoretic patterns for opium extracts from opiums of different sources. The electropherograms were developed in a phosphate-citrate buffer at a pH of 5·0 as described in the text.

The data obtained suggests that this technique can be used for distinguishing opium samples of different countries of origin. Combined with the other established methods for determining origin such as the microscopic test, porphyroxine-meconidine value, codeine percentage and ash analysis, this technique of electrophoresis will permit positive origin identification of different samples of opium.

The toxicologist is required to detect the presence or absence of alkaloids and related basic drugs in viscera. The Stas-Otto process involves many steps and the final extract contains large amount of normal tissue extractives which interfere with the chemical and physical tests used in the identification of these drugs. A direct extraction of the tissue with a solvent like ethyl ether followed by the purification of ether extract using the technique of paper electrophoresis have many advantages. By this method, the suspected component can be separated from many normal extractives. The use of sensitive spotting agents makes for increased sensitivity in detecting or ruling out basic drugs. A quantitative estimation of concentration may be made by comparison of the spots with known standards. The compounds may be recovered in relatively pure state by proper elution and subsequent extraction by immiscible solvent.

After the run of electrophoresis, the dry paper strip is first examined in the dark with the ultraviolet light. Those basic drugs that are strongly fluorescent such as quinine, quinacrine and others are readily located in concentrations of less than 1 microgram. The fluorescence of these drugs is different from those of the normal tissue extractives. Compounds that strongly absorb ultraviolet light will be seen as dark areas on the paper. Strychnine and many other antihistaminic drugs can be located on the paper when present in concentrations of less than 10 micrograms. After marking the areas of fluorescence or absorption, the paper is sprayed with iodoplatinic acid. This reagent reacts with basic compounds to form blue or black areas. As little as 10 micrograms of most basic drugs can be detected with this reagent. For the detection of compounds such as adrenaline, amphetamine, methamphetamine and others, dinitrofluorobenzene is used as a spotting reagent. After first spraying the paper with iodoplatinic acid, any dark areas that appear are cut out and saved for elution. The remainder of the paper is sprayed with a solution of 2% sodium carbonate. This decolorises the brown iodoplatinic reagent and furnishes the necessary alkalinity for the reaction of primary amine with dinitrofluorobenzene. Deep yellow areas appear that remain coloured after dipping the dry paper in dilute hydrochloric acid, if aliphatic amines are present.

Fresh drug-free samples of tissues, especially, liver when carried through the above procedure, will contain small amounts of basic compounds. These compounds appear, when present, as fast moving components. They can be located as a dark spot in ultraviolet light and will form a black spot after spraying with iodoplatinic acid reagent. Another compound will appear after spraying with dinitrofluorobenzene indicating the aliphatic amine. The latter compounds are present in large amounts after putrefaction and will be in such high concentration as to give dark compounds with iodoplatinic acid.

By the employment of this technique, it will be possible to differentiate between the extraneous basic drugs, and the amine that might be

produced by putrefaction. Electrophoresis is, therefore, a valuable tool in the hands of toxicologists for giving a definite opinion as to the presence or absence of a basic drug or poison in viscera, particularly, when putrefaction has already taken place.

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HIGH RESOLUTION RAMAN SPECTRA OF C_2H_4 AND C_2D_4

THE unique importance of the molecular structure of ethylene for valence theory has made this molecule a favourite for spectroscopic studies at high resolution. Early studies of the pure rotational Raman spectrum of ethylene were interpreted in terms of a symmetric and near-symmetric top molecule. These studies have led to the much quoted parameters r (C = C) = 1·353 A, r (C-H) = 1·071 A, and $\angle$ (H-C-H = 120°, for the structure of the ethylene molecule.

Dowling and Stoicheff have given the results of a detailed analysis of the pure Rotational Raman Spectra of C_2H_4 and C_2D_4 under high resolution [*Canad. J. Phys.*, 37 (6), 703-21]. The spectra were photographed in the second order of a 21 ft. grating. The resolution achieved was high enough to warrant analysis based on the non-rigid asymmetric top. Several lines were identified as single transitions and their analysis has led to an accurate evaluation of the rotational constants for the ground states. The structural parameters of ethylene obtained from these constants are given below, compared with their values obtained by infra-red spectroscopy and electron diffraction method.

	r_0 (C=C)	r_0 (C–H)	$\angle$H-C-H
Raman ..	1·339 ±0·002 Å	1·086 ±0·003 Å	117° 34′ ± 30′
Infra-red ..	1·337 ± ·003	1·086 ±0·003	117° 22′ ± 1°
Electron diffraction	1·334 ±0·003	1·085 ±0·005	116° ± 1°

NATIONAL PHYSICAL LABORATORY (ENGLAND)—ANNUAL REPORT FOR 1958*

THE Report outlines the recent reorganization at the NPL and the new trends in its research work. The replacement of three of the old Divisions by the new Divisions of Applied Physics, Basic Physics and Standards has enabled the Laboratory to plan research into new fields. The new Basic Physics Division is equipping itself to begin work mainly devoted to the relation between the macroscopic properties of materials and their structure on a molecular scale. In the Applied Physics Division, work has begun on radiocarbon dating and a national centre for neutron source standardisation is being formed. A new item in the Standards Division is the accurate determination of the gyromagnetic ratio of the proton which will open the way to precise measurement of strong magnetic fields and hence to the accurate determination of a number of important fundamental constants.

Other new aspects of the programme include the increasing attention of Aerodynamics Division to the behaviour of gases at the high temperatures associated with high speed flight, and to the development by the Control Mechanisms and Electronics Divisions of new components for very high-speed computers. The Light Division has made progress with some interesting new ideas in the application of gratings to linear and angular measurement and to the control of machine tools. The Metallurgy Division has been concentrating particularly on fine structure of metals, movements of dislocations and their relation to physical and mechanical properties. A group is being set up in the Mathematics Division to consider the theoretical aspects of experimental work being carried out in other Divisions.

* Published for D.S.I.R. by H.M.S.O., price 8*s*.

LETTERS TO THE EDITOR

A SMALL FURNACE FOR USE WITH SEIFERT X-RAY DIFFRACTOMETER

A NUMBER of high temperature powder cameras employing films for recording X-ray lines are described in literature; but hardly a few[1–3] furnaces are described which can be used with a recording diffractometer. Moreover the materials recommended for use in such furnaces are not obtainable in ordinary laboratories. The furnace described in this note is assembled from materials available in our laboratory and has been designed for Seifert X-ray diffractometer which employs Bragg-Brentano focussing.

The furnace, Fig. 1, consists of a piece B of size 2" × 2" × 0·3" cut from a hardened and

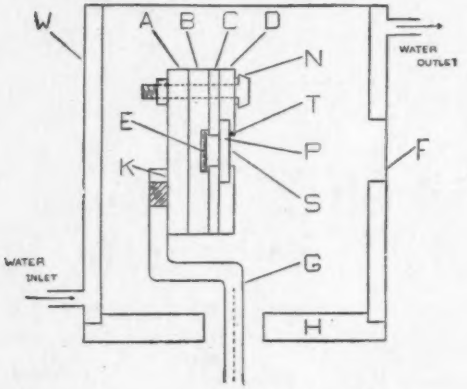

FIG. 1

burnt out brick from a spoiled electric muffle-furnace. It has a groove of about one inch diameter in the middle. The heating element E consists of a coiled coil spiral of platinum + 10% rhodium wire of length 6' and diameter 0·3 mm. The spiral is fitted in the groove in B. A, C and D are asbestos sheets. A platinum plate P of about 1" diameter and thickness 0·4 mm. is pressed between B and C. The thickness of C is kept small so as to leave a small gap between the heating element and the plate. This ensures quick rise of temperature and prevents short-circuiting. The powder under investigation is pressed on the front surface S of the plate. The whole assembly is kept together by four screws N fitted at the four corners of the furnace. A platinum-platinum + 10% rhodium thermocouple is put at the point T. The glass rod G holds the furnace at its upper end while its lower end fits into the central hole of the diffractometer plate. The glass rod serves as an insulator between the furnace and the diffractometer plate. A circular brass plate H is fixed on the diffractometer plate at its centre. On this brass plate stands a cylindrical jacket W in which water is circulated in order to ensure uniformity of conditions. The water jacket has an opening in front of the platinum plate P for the entrance and exit of X-rays. The opening is covered with a thin aluminium foil F.

The plate of the specimen can be made to coincide with the vertical axis of rotation (shown dotted) by inserting packings at K between the glass rod and the sheet A. The furnace has been used up to a maximum temperature of 800° C. The same furnace with slight modifications can be used with a back reflection camera.

Some of the requirements of a good furnace to be employed with a diffractometer are: (i) small size so as to avoid rise of temperature of diffractometer itself, (ii) quick response,

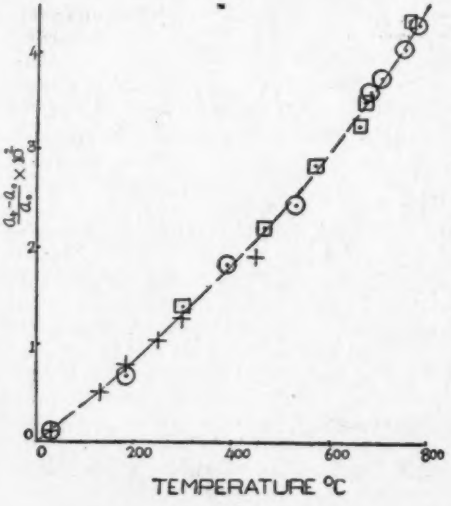

FIG. 2

— — — dilatometric observations (smoothed) Eucken and Dannöhl[4]; ⊙ : present measurements; □ : Fischmeister[5]; + : Basu and Maitra[6].

(iii) constancy of its calibration curve. The present furnace satisfies these requirements. Typical observations on NaCl up to its melting point are given in Fig. 2 in which the relative increase of the cell constant referred to its value at 0° C. is plotted against temperature.

M.G. Science Institute, Ahmedabad 9,
May 2, 1959.

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N. V. PANDYA.

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ELECTRO-OSMOSIS IN ION-EXCHANGE RESIN MEMBRANES

THERE are four recorded examples[1–4] of measurements of electro-osmosis in ion-exchange resin membranes. Lakshminarayanaiah[4] has covered a wider range of conditions measuring electro-osmosis through 5%, 10% and 15% cross-linked polymethacrylic acid (PMA) resin membranes in various alkali metal forms and through sulphonated phenol-formaldehyde (PSA) resin membranes in Na and K forms. A typical result for the system 0·01 N NaCl-Na (PSA) membrane—0·01 N NaCl is recorded (Fig. 1).

Unambiguous explanation of the phenomenon depicted by the curve is not forthcoming, although the following tentative and qualitative explanations have been offered :

(*a*) It is believed that there are two types of current carriers in the resin phase. At low current densities, ions in the diffuse part of the double layer carry the greater part of the current and at high current densities, all the counter ions participate giving a limiting value to the volume of liquid transported through the membrane for the passage of a Faraday of Current.

(*b*) Variation of electro-osmosis with current density is due to some chemical change in the membrane, probably concentration polarisation[5] induced by electrolysis. This phenomenon, though it has not been thoroughly investigated in these systems, has been shown to be not the cause. It is based on the evidence of electrical conductance of H-form and Na-form PMA and PSA resins.[4]

(*c*) The heterogeneous character of the membrane is responsible for the peculiar behaviour. The membrane has pores of various sizes charged differently. At low currents, the uncharged or slightly charged pores seem to be selectively active electro-osmotically and at high currents, every pore is active giving an average value for the electro-osmotic flow of liquid through the membrane.

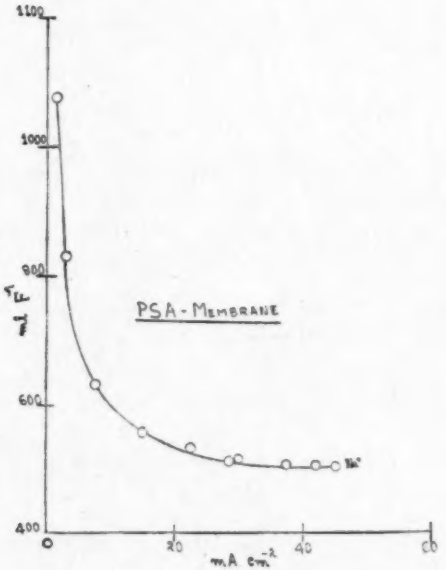
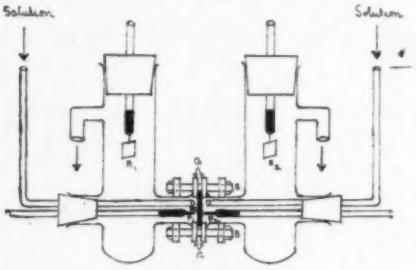


FIG. 1

Though explanation (*b*) has been dismissed it needs thorough investigation. Explanation (*a*) implies an apparent breakdown of Ohm's law. It is important to establish if these systems, solution ⇄ Membrane ⇄ solution, obey Ohm's law or not, although the electrical conductance of these systems have been measured accurately employing the A.C. technique.[6–10]

Using the direct current method of Gordon and Gunning,[11] resistance of the system, solution ⇄ Na-form PSA membrane ⇄ solution, has been measured as a function of current density employing 0·01 N, 0·1 N and 1·0 N NaCl external electrolyte solutions. With 0·01 N NaCl external solution, the resistance of the system rose significantly with increase of current due to depletion of ions in the region of the probe electrodes P_1, and P_2 (Fig. 2). This was eliminated by flowing the solution over the membrane surface. In all the measurements, this technique was employed.

Stout reversible Ag-AgCl electrodes R_1 and R_2 carried the current through the system. For



M = Membrane
G = Rubber Gaskets
B = Brass Bars

FIG. 2

fixed positions of Ag-AgCl probes, the resistance remained constant in each case (Table I)

TABLE I

External solution	Current density mA/cm.^{2}	Resistance Ω
0·01 N NaCl ..	0·14	516
	0·19	515
	0·33	518
	0·45	517
	0·64	519
0·1 N NaCl ..	0·11	79·0
	0·36	78·8
	0·63	78·9
	0·93	78·8
1·0 N NaCl ..	0·09	15·0
	0·17	14·8
	0·32	14·8
	0·44	14·7
	1·38	14·8

irrespective of the current passed through, confirming the applicability of Ohm's law to these systems. So postulation of the existence of two types of ions in the membrane phase to explain the electro-osmotic curve (Fig. 1) becomes unreal.

The other probable factor, *viz.*, the heteroporosity of the resin phase, causing the observed electro-osmotic flow, is under study.

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ANION EXCHANGE RESINS AS CATALYST IN THE SYNTHESIS OF PYRIDINE DERIVATIVES

ANION exchange resins are widely used as catalyst in numerous organic reactions. In the synthesis of pyridine derivatives, the use of anion exchange resins as catalyst has not been reported so far. It is now found that cyanoacetamide condenses with acetylacetone in presence of Amberlite IRA-400 to give 3-cyano-4 : 6-dimethyl-2-pyridone in good yield. The experimental procedure is as follows :—

Amberlite IRA-400 (A.G.) was washed with 5% sodium hydroxide solution (5 to 6 times the volume of the resin) in a Buchner funnel. The resin was rinsed with distilled water until the washings were neutral, and was air dried before use. Amberlite IRA-400 (4 g.) was added to a saturated solution of cyanoacetamide (4·2 g) and acetylacetone (5 g.) in alcohol and the reaction mixture was refluxed for 3 to 4 hr. on steam bath. The reaction mixture was then filtered hot to remove the resin. The filtrate, on cooling, gave a crystalline product. This was collected on filter, washed with cold alcohol and crystallized from alcohol in white shining needles. M.p. and mixed m.p. with an authentic sample of 3-cyano-4 : 6-dimethyl-2-pyridone[1] was 289°. Yield 5 g.

Synthesis of other pyridine derivatives using the anion exchange resins as catalyst is in progress.

I am thankful to Prof. Suresh M. Sethna for his guidance and help.

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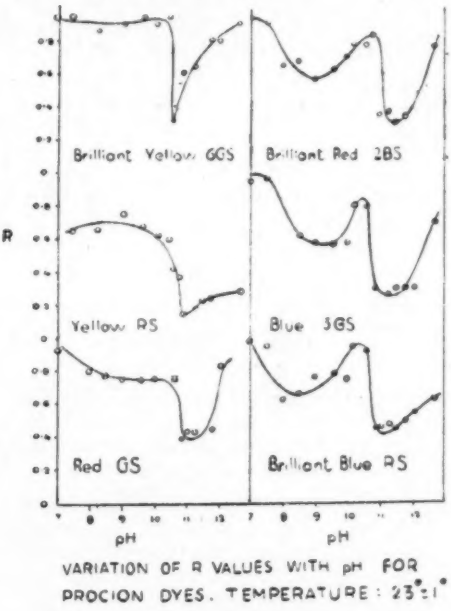
A CHROMATOGRAPHIC STUDY OF SOME REACTIVE DYESTUFFS

RECENTLY chemically reactive dyestuffs have been put on the market by I.C.I., Ciba and Farbwerke Hoechst under the trade names Procion, Cibacron and Remazol respectively. These dyes[1–3] all have the common characteristic of forming a chemical linkage with cellulose but only in alkaline media, the rate and extent of reaction being dependent on pH and temperature. In alkaline solutions the dyes also undergo hydrolysis forming what are called inactive dyes and which have practically no substantivity for cellulose, a property which is also shared by the active dyes when in neutral solutions.

In view of these unique properties of reactive dyes it was thought that a circular paper chromatographic study of these dyes as a function of pH using cellulose filter-paper would lead to some interesting results. Chromatograms under identical conditions were therefore taken on 12·5 cm. diameter Whatman No. 1 filter-paper discs using Rutter's method.[4] The developing solutions were buffer mixtures covering the pH range 6·9–12·7. Cold brand Procion dyestuffs were used in these experiments. These highly reactive dyestuffs contain two labile chlorine atoms of relatively high reactivity and are formed by linking cyanuric chloride with water soluble azo or anthraquinone dyes that contain an amino group. These two labile chlorine atoms are available for combination with cellulose.[1c] 0·2% aqueous solutions of the commercial dyes were used in all the experiments. After marking the positions of the different zones the chromatograms were soaped and boiled in order to remove inactive hydrolysed dye. R values for chemically combined dye were measured in all cases, R being defined as the ratio of distance travelled by dye to that travelled by the solvent front in the same time. The variation of R with pH is presented graphically in Fig. 1.

During the development of the chromatogram the adsorbed dye can react partly with the cellulose of the filter-paper forming a chemically fixed coloured zone, get hydrolysed partly to the inactive form and while the developing solvent advances, unreacted active dye and the hydrolysed inactive dye will diffuse out forming outer coloured zones of further chemically combined dye and loosely bound physically adsorbed inactive dye respectively. The Procion dyes studied show this expected behaviour when chromatographed. The extent of spread of the zones and the formation of more than one chemically combined zone is dependent on the relative reactivities and affinities of the dye for cellulose as well as the pH of the eluting solvent.



VARIATION OF R VALUES WITH pH FOR PROCION DYES. TEMPERATURE : 23°±1°

FIG. 1

From Fig. 1 it is clear that R has minimum values depending on pH. For Procion Yellow RS, Brilliant Yellow 6 GS and Red GS there is a single sharp minimum value for R and it is interesting to note that the pH corresponding to this minimum R value is almost identical with the optimum pH value for percentage maximum fixation of the dye on cotton in the same temperature range.[5] In the case of Procion Brilliant Red 2 BS, Brilliant Blue 3 GS and Blue RS, R is a minimum at two or more pH values. These minima are not sharp and also there is no specific correlation between the value of optimum pH for maximum percentage fixation and the pH corresponding to a minimum R value, but it is noteworthy that Procion Brilliant Red 2 BS has peak fixation values at more than one pH value.[5] At high alkali concentration it is clear that the reaction between these dyes and cellulose is quite complex. A general conclusion which can be drawn from the data obtained is that the rate of reaction with cellulose is governed by several factors and is not always instantaneous,[1c] since zones of chemically combined dye

having high R values are obtained both at low and high pH values. A detailed study of these and other aspects of this investigation will be published elsewhere.

The authors' thanks are due to Dr. B. K. Vaidya for his keen interest during the course of this work and to Messrs. I.C.I. Ltd., Bombay, for the supply of free dyestuff samples.

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TETRAHYDROXYQUINONE AS AN ANALYTICAL REAGENT AND ITS RELATIONSHIP WITH SODIUM RHODIZONATE

SODIUM rhodizonate is an important reagent; it gives colour reactions with a large number of cations[1] and has been largely used in chromatographic spotting. Tetrahydroxyquinone is also known to give coloured products with Ba^{++}, Pb^{++} and Sr^{++}.[2,3]

Previous workers have described potassium and sodium rhodizonate as a violet crystalline compound and sodium tetrahydroxyquinone as a dark green crystalline compound.[4,5] Hoglan and Bartow[6] prepared both sodium tetrahydroxyquinone and sodium rhodizonate by the oxidation of inositol. These salts on acidification gave bluish black crystals, which gave the same benzoyl derivative, m.p. 266-70°. The above workers therefore doubted whether they are two different compounds.

We found that tetrahydroxyquinone reacts with a large number of cations, *viz.*, Pb^{++}, Tl^{+} Ag^{++}, Hg^{++}, Ba^{++}, Sr^{++}, Ca^{++}, Mg^{++}, Bi^{+++} Cd^{++}, Cu^{++}, Zn^{++}, Sn^{++}, and UO_2^{++} and the colour reactions are the same as described for sodium rhodizonate.[1] It is very unlikely that two different compounds should give the same colour reactions with a large number of cations. We, therefore, concluded that tetrahydroxyquinone and rhodizonic acid are not two different compounds. Further we analysed a dried pro-analysi sample of sodium rhodizonate (E. Merck) and the results indicated 1% hydrogen corresponding to sodium tetrahydroxyquinone.

The following colour reactions have also been noted in neutral solutions. ZrO_2^{++} red; Th^{++++} blue; Ce^{+++} blue (Ce^{++++} oxidises the reagent).

Further, a solution of the so-called sodium rhodizonate is readily decomposed[1] being alkaline. A solution of tetrahydroxyquinone is more stable and we have observed that in the presence of a little acetic acid and formaldehyde it remains unchanged for about a week.

Our thanks are due to Prof. T. R. Seshadri for helpful discussions.

Department of Chemistry, University of Delhi, Delhi 8, *July* 13, 1959. S. P. SINGHAL. B. D. JAIN.

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BEHAVIOUR OF A MIXTURE OF NITROUS OXIDE AND HYDROGEN UNDER SPARK DISCHARGE

THE thermal reaction between nitrous oxide and hydrogen has been extensively studied.[1-4] Studies in the production of a periodicity effect under silent discharge,[5,6] suggested the desirability of the present extension of work, *viz.*, to investigate the reaction under spark discharge. The following experiments were conducted to find out whether a periodicity effect in the pressure *vs.* duration of exposure curve, similar to that observed under the silent discharge, was produced under the spark discharge.

The experimental procedure was essentially similar to that adopted earlier.[5] The ozonizer was replaced by a glass bulb of about 50 c.c. capacity attached to the capillary manometer by a stop-cock and to the mixture reservoir ($N_2O + H_2$) by another stop-cock. The bulb was evacuated by the Töpler.

The results are given in Table I. The reaction under spark discharge shows an overall diminution of pressure to a constant minimum. There is a marked limitation in respect of the initial pressure of the reaction mixture (72 mm. Hg) beyond which the reaction tends to become explosive; this limiting pressure would depend upon the sparking distance, as it determines the relevant field. At higher pressure, the detonation is attended by a sudden

TABLE I

Spark length = 7 mm. (Aluminium disc 1 cm. in diameter)

Ratio N_2O/H_2 (By valume at N.T.P.)	Initial pressure of N_2O+H_2 mixture (mm.Hg)	Applied potential minimum volts (r.m.s.)	Frequency of the A.C. supply c/s	Pressure diminution (net change)	
				Obs. (mm. Hg)	Cal. * (mm. Hg)
24·2 / 75·8	72	1900	50	57	54 (no explosion occurred)
do.	85	2400	do.	66	65
do.	102	2700	do.	82	77
do.	112	2900	do.	90	85
do.	120	3200	do	92	91
do.	134	3500	do.	107	102
51·2 / 48·8	200	4800	50	110	102
do.	252	5100	do.	132	129
do.	247	500	500	127	126
do.	263	500	do.	146	135
70·4 / 29·6	149	3700	50	108	105
do.	242	5300	do.	181	170

* For the reaction : $N_2O + H_2 = N_2 + H_2O$ (Liquid).

change of pressure, a characteristic click and a flash of light. These features are accentuated at still higher pressure for the same gaseous composition. Final pressure has been recorded after allowing the bulb to cool for about two hours. Periodicity effect is not observed even when the gaseous mixture contains either an initial excess of nitrous oxide or hydrogen or when the ratio of the two components is roughly equal to 1 : 1. The reaction under spark discharge is principally attributed to the thermal action of the spark (as distinct from its associated electrical influences) since it yields nitrogen and water as its final products which are identical with those observed in the thermal change.[7,8] $N_2O + H_2 = N_2 + H_2O$.

The author wishes to express sincere thanks to Dr. S. S. Joshi, Head of Chemistry Department, Benares Hindu University, for his kind interest and helpful suggestions during the course of this research in his laboratory.

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THE MECHANISM OF OXIDATION OF SECONDARY ALCOHOLS BY CHROMIC ACID

CHROMIC acid oxidations are generally considered to involve essentially a dehydrogenation of the carbon compound oxidised, and the generally accepted mechanism is the one put forward by Westheimer[6] on the basis of his studies with isopropyl alcohol. This general acceptance has even led to devious reasoning to explain away any apparent contradictions in a few cases. The essential features of this mechanism are (i) the preformation by a rapid reversible reaction of an acid ester, a monoalkyl chromate, followed by (ii) interaction with a base, *e.g.*, water, in the slow rate-determining step. In this last step, it is assumed that the chromium is reduced to a tetravalent compound and the hydrogen atom at the secondary

carbon atom carrying the hydroxyl group is removed as a proton.

While the rupture of the secondary C-H bond in the rate-determining step is on fairly certain grounds,[7] one cannot readily accept the position that the isolation of a neutral ester of the alcohol with chromic acid is adequate for postulating ester formation as the crucial initial step followed by the subsequent decomposition. The validity has also been questioned by Rocek[5] who has suggested an alternative cyclic mechanism. Further doubt on the mechanism is cast by the clear observations that the reaction is faster in media containing less water as in acetic acid of various dilutions. We are unable to accept the explanations offered for this abnormality.[8]

In a previous communication[1] we had indicated the complex nature of the reaction. We find that the reaction is slowest in 30% acetic acid and fastest in 80% acetic acid in the range of solvent compositions. The order of reactivity closely follows the conditions for stabilising carbonium ions.[2] It was anticipated that the study of a series of secondary alcohols would provide the answer. The results of these studies clearly substantiate our anticipations.

The formation of a carbonium ion in the rate-determining step together with the removal of the C-H hydrogen at the secondary carbon atom as an anion, removes some of the anomalies noticed. Thus the observations of Kwart and Francis[3] on the role of substituents in the oxidation of *p*-substituted alpha-phenylethanols are in the proper order $CH_3O->$ tert $C_4H_9->$ $CH_3->$ $H->$ $Cl->$ NO_2- and the nitro group does not present any abnormality to be explained away with difficulty by adopting Westheimer's mechanism as the authors have done. Similarly Ogata, Fukui and Yuguchi[4] report the order $H->$ $Br->$ $Cl->$ $CN->$ NO_2 in the oxidation by chromic acid of *p*-substituted toluenes. This also conforms to the order to be expected for removal of hydrogen as an anion in the rate-determining step.

The mechanism of esterification and hydrolysis is now fairly well established and it is generally found that this involves an activation energy of the order of 16,000 calories while in the series of compounds investigated, this is invariably about 2,000 calories less. While one can accept the formation of an ester in a concurrent reaction, it is obvious that esterification need not be a prerequisite for the oxidation (*cf.* Rocek[5]).

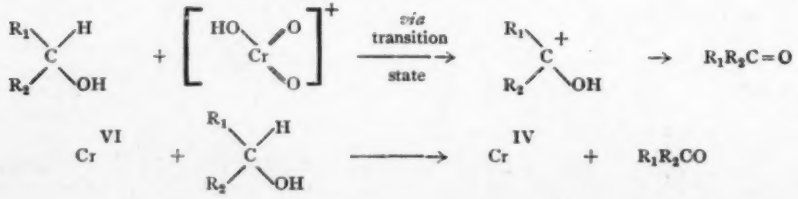
TABLE I

Rate of oxidation of secondary alcohols at 40° C. ($k_2 \times 10^5$)

Alcohol	Solvent composition : % Acetic acid (v/v)					
	30	40	50	60	70	80
Propan-2-ol ..	0·9822	1·985	3·9047	8·353	19·03	..
Butan-2-ol ..	1·7146	3·4494	7·152	14·45	34·67	..
Pentan-2-ol ..	2·317	4·786	9·348	18·704	42·58	..
Octan-2-ol ..	..	..	..	16·60	38·02	99·19
Alpha-phenyl ethanol ..	..	..	2·422	4·610	10·123	23·22
Benzhydrol ..	..	..	6·026	8·640	18·20	50·12

All rate constants are in units of mol/l., sec.$^{-1} \times 10^5$ and refer to a second order reaction at constant hydrogen-ion concentration and constant ionic strength.

The following tentative mechanism for the oxidation may be suggested to account for all the behaviour so far observed :



followed by one of the following:

$$\text{I}\begin{cases} 2Cr^4 + \text{secondary alcohol} \longrightarrow 2Cr^3 + \text{ketone} & a \\ Cr^4 + \text{secondary alcohol} \longrightarrow Cr^2 + \text{ketone} & b \\ Cr^2 + Cr^4 \longrightarrow 2Cr^3 & c \end{cases}$$

$$\text{II}\begin{cases} Cr^2 + Cr^6 \longrightarrow Cr^3 + Cr^5 & a \\ Cr^4 + Cr^6 \longrightarrow 2Cr^5 & b \\ 2Cr^4 \longrightarrow Cr^3 + Cr^5 & c \\ Cr^5 + \text{secondary alcohol} \longrightarrow Cr^3 + \text{ketone} & d \end{cases}$$

Evidence is as yet inadequate as to the process by which the chromium is reduced to the tervalent state by the reducing agent. Full details will be published shortly elsewhere.

Dept. of Chemistry, Madras Christian College, Tambaram, *June* 16, 1959.

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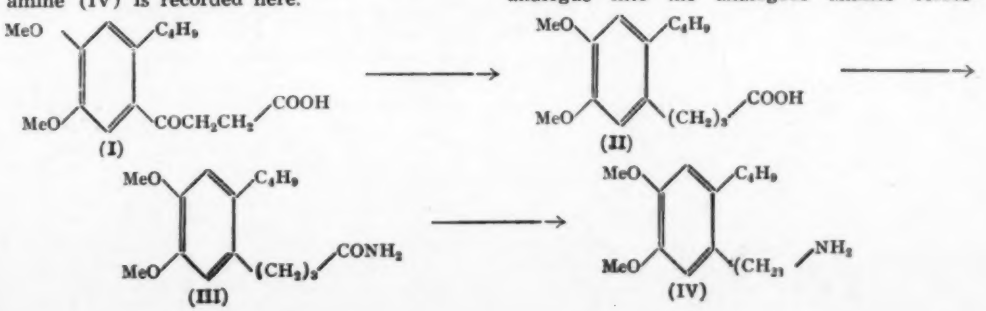
SYNTHESIS OF γ-(2-*n*-BUTYL-4 : 5-DIMETHOXYPHENYL)-*n*-PROPYLAMINE

β and α-(2-alkyl-4 : 5-dimethoxyphenyl)-ethylamines were prepared by Kachru and Pathak[1] which were tested *in vitro* for amœbicidal activity by Kaushiva[2] who observed greater amœbicidal activity in β-series. It would be desirable to determine the effect on the amœbicidal activity if the amino group is further removed from the nucleus by one more C-atom. Thus the synthesis of γ-(2-alkyl-4 : 5-dimethoxyphenyl)-propylamines was taken up; those with alkyl groups as methyl, ethyl and propyl have already been described[3]; that of γ-(2-*n*-butyl-4 : 5-dimethoxyphenyl)-*n*-propylamine (IV) is recorded here.

3 : 4-Dimethoxy-*n*-butylbenzene, prepared according to the procedure adopted by Kachru and Pathak,[1] was condensed with succinic anhydride in nitrobenzene in the presence of anhydrous aluminium chloride to yield β-(2-*n*-butyl-4 : 5-dimethoxybenzoyl)-propionic acid (I), crystallised from dilute alcohol, m.p. 100° (Found: C, 65·36; H, 7·53. $C_{16}H_{22}O_5$ requires C, 65·31; H, 7·48%). Likewise β-(2-*n*-amyl-4 : 5-dimethoxybenzoyl)-propionic acid, m.p. 98° and β-(2-*n*-hexyl-4 : 5-dimethoxybenzoyl)-propionic acid, m.p. 92° were also prepared. Clemmensen reduction of the keto acid (I) with toluene as the solvent gave γ-(2-*n*-butyl-4 : 5-dimethoxyphenyl)-*n*-butyric acid (II), b.p. 218°/1 mm., m.p. 66° (Found: C, 68·45; H, 8·39. $C_{16}H_{24}O_4$ requires C, 68·57; H, 8·52%). Correspondingly γ-(2-*n*-amyl-4 : 5-dimethoxyphenyl)-*n*-butyric acid, m.p. 81° and γ-(2-*n*-hexyl-4 : 5-dimethoxyphenyl)-*n*-butyric acid, m.p. 83° were obtained. Out of these three acids only (II) provided the amide (III), m.p. 103° (Found: N, 5·20. $C_{16}H_{25}O_3N$ requires N, 5·01%), other acids resinified both during the preparation of the acid chlorides and the ammonium salts. The amide (III) by Hofmann reaction of treatment with sodium hypochlorite yielded the desired amine (IV), picrate m.p. 137°, the *amine hydrochloride* crystallised from ethyl acetate, m.p. 202°, with decomp. (Found: C, 62·73; H, 9·13; N, 4·74. $C_{15}H_{26}O_2NCl$ requires C, 62·61; H, 9·04; N, 4·87%.) Conversion of γ-(2-*n*-amyl-4 : 5-dimethoxyphenyl-*n*-butyric acid and its *n*-hexyl analogue into the analogous amines corres-



ponding to (IV) failed even by Curtius and Schmidt reactions.

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ON THE VOLUMETRIC ESTIMATION OF FLUORIDE BY THORIUM NITRATE

THE method of Willard and Winter[1] for the volumetric estimation of fluoride by thorium nitrate using alizarin red S as indicator is a general laboratory procedure. However, the difficulty in noting the end point in this volumetric estimation cannot be over-emphasized.[2] The adsorption of the red coloured complex on the thorium fluoride precipitate gives rise to the difficulty in observing sharp change in colour from yellow to pink at the end point. In the present note a modified method is suggested to overcome the difficulty. It consists in filtering the thorium fluoride precipitate before the end point is reached. This eliminates the adsorption of the red coloured thorium complex with alizarin red S on the fluoride precipitate. It has been found that the end point becomes unmistakably sharp after filtration.

It is necessary when applying this method of estimation of fluoride that either the approximate volume of thorium nitrate solution (N/10) required be known or a rough titration be carried out till red colour appears. For accurate titration, a volume which is short of the approximate volume by 2 to 3 ml. is added straight from the burette to the fluoride solution in the conical flask, maintained at pH 2·9 to 3·4 using monochloro acetic acid-sodium monochloro acetate buffer (*loc. cit.*). The thorium fluoride precipitate formed is filtered off. The flask and the precipitate are next washed into the filtrate with small quantities of the solution of monochloro acetic acid-sodium monochloro acetate having the same pH as the filtrate. The indicator is added and the titration continued. The end point becomes sharp and can be noted with a drop.

Estimations of fluoride, for two solutions in duplicate, carried out by us are shown in Table I. The figures show the values obtained by the modified volumetric method and those obtained gravimetrically by the method adopted by Badeeva.[3]

TABLE I
Fluorine content in mg.

	Volumetric method	Gravimetric method
Soln. I ..	30·4	30·5
	30·4	30·4
Soln. II ..	47·4	47·5
	47·4	47·4

It can be seen that the modification involving just one filtration before the end point makes the method reliable.

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Ravenshaw College, I. B. MISHRA.
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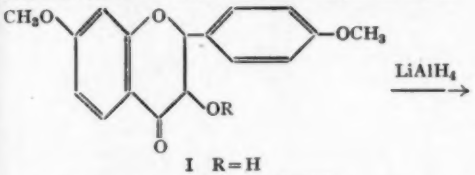
SYNTHESIS OF CRYSTALLINE LEUCOANTHOCYANIDINS RELATED TO GUIBOURTACACIDIN

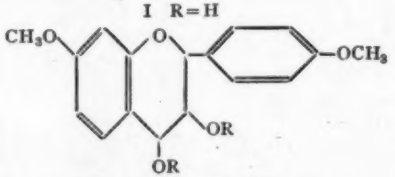
RECENTLY Roux[1] has indicated the presence of a new leucoanthocyanidin "Guibourtacacidin" in the species of genus *Guibortia* and has suggested it to be 7 : 4′-dihydroxyflavan-3 : 4-diol. The present communication reports the synthesis of flavan-3 : 4-diols isomeric in position "4" and having the above basic structure.

7 : 4′-Dimethoxydihydroflavonol (I), m.p. 133° required for the purpose was prepared by the procedure described by Joshi and Kulkarni.[2] On reduction of the above dihydroflavonol with lithium aluminium hydride a mixture of flavan-3 : 4-diols with a melting point range 113-21° was obtained. The mixture could be conveniently separated by acetylating it and crystallising the diacetates. The diacetate (III), m.p. 132° (Found : C, 65·6 ; H, 6·0 ; $C_{21}H_{22}O_7$ requires C, 65·3 ; H, 5·7%) separated out first. On hydrolysis with alcoholic sodium carbonate the corresponding diol (II), m.p. 114-15° (Found ; C, 67·1 ; H, 6·2 ; $C_{17}H_{18}O_5$ requires C, 67·5 ; H, 6·0%) was obtained. The mother liquor was then similarly hydrolysed and the mixture of

diols now richer in the other isomer was obtained. It was crystallised several times from alcohol when another diol (IV), m.p. 136° (Found : C, 67·8 ; H, 6·2 ; $C_{17}H_{18}O_5$ requires C, 67·5 ; H, 6·0%) was obtained. It was characterised by preparing the dibenzoate (V), m.p. 159° (Found : C, 72·7 ; H, 5·0 ; $C_{31}H_{26}O_7$ requires C, 72·9 ; H, 5·0%). Both these diols (II and IV) on warming with alcohol and hydrochloric acid gave pink colour[3–6] which changed to yellow on keeping and a violet colouration with concentrated sulphuric acid.



I R=H



II R=H, m.p. 114-15°
III R=$-COCH_3$, m.p. 132°
IV R=H, m.p. 136°
V R=$-COC_6H_5$, m.p. 159°

The diol (II) could be obtained in a quantitative yield on reduction of the dihydroflavonol with sodium borohydride. On the basis of the stereospecificity[7] of reducing agents and the hypothesis of Joshi and Kulkarni,[8] this diol is assigned 2 : 3-*trans*-3 : 4-*cis* configuration and is most probably identical with "Guibourtacacidin" dimethyl ether. The other diol could then have 2 : 3-*trans*-3 : 4-*trans* configuration.

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ON THE BIOLOGICAL ESTIMATION OF ADRENALINE AND THE OXYTOCIC PRINCIPLE OF PITUITARY POSTERIOR LOBE EXTRACT WHEN PRESENT IN A MIXTURE

For cardiac or nephritic dyspnœa, collapse and bronchial asthma a mixture of adrenaline and pituitary posterior lobe powder extract is often used. Strengths of adrenaline and the oxytocic activity of extract of posterior pituitary lobe powder are generally found to be of the order of 0·5 mg. and 5 I.U. per ml. respectively. Both being vasopressor in action, it is difficult to estimate the potency of such a preparation by the customary biological assay method. As such an attempt was made to separate and subsequently estimate each component in such a pharmaceutical preparation. This has been made possible by the application of ion-exchange chromatography.

An aliquot (2 ml.) of a preparation containing adrenaline (0·5 mg. per ml.) and pituitary (5 I.U. per ml.) was percolated through a column (5 × 0·5 cm.) of Zeokarb 215 (H. form), followed by distilled water to make the volume of the percolate to 25 ml. Adrenaline was adsorbed on the resin, the pituitary oxytocic principle separating out in the percolate.

The percolate was then diluted 8 times to have 0·05 I.U. per ml. and subjected to biological assay on the uterus of virgin guineapig in comparison with a standard preparation containing 0·05 I.U./ml. Results of the assay indicated complete recovery of the principle.

Adrenaline was eluted from the resin with ice-cold 3 N hydrochloric acid (10 ml.), followed by distilled water (5 ml.). The eluate was adjusted to pH 2·5 with sodium hydroxide (about 10%) in cold (0—5° C.) and the final volume made up to 25 ml. It was then assayed biologically on a spinal cat against a standard preparation containing adrenaline chloride (1 : 25,000). The recovery was almost complete. Similar experiments were repeated with solution containing adrenaline tartrate or adrenaline malate admixed with pituitary extract and it was found that here also the two constituents in a mixture could be easily estimated within experimental error.

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Bengal Immunity Res. Inst., S. K. Ganguly.
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April 14, 1959. S. K. Dutta.

A NOTE ON TWIN LAWS IN PLAGIOCLASE FELSPARS FROM CERTAIN GRANITIC AND ASSOCIATED ROCK TYPES OF NANDI

PETROLOGICAL literature of last thirty years abounds in many references to the nature and origin of twins in plagioclase felspars. In recent times workers like Gorai (1951),[2] Suwa (1956),[5] Turner (1951)[6] have given thought to the distinctiveness of particular twin law or laws in a series of rocks. In the present study an attempt is made to record some of the twin types encountered in plagioclase felspars of granites and associated rock types from Nandi Hills, situated in Kolar District, Mysore State (Long. 77° 40′, Lat. 13° 22′).

The rocks around Nandi are made up of medium to fine grained grey granites, granodiorites and gneissic-granites. Besides this a few xenolith patches of amphibolites were also noticed. About 35 representative samples were collected and 80 thin sections were prepared out of them. 226 felspar grains from granites, granodiorites, gneissic-granites and amphibolites were analysed for anorthite content and twin laws, according to the methods of Reinhard (1931).[4] The twin axes were located by using Nikitin and Berek construction. The above observations, as far as possible, were further checked by noting the angles between twinning axis and optic elasticity axes. The observed values of anorthite content are shown in Table I.

TABLE I
Nature of plagioclase felspar

Rock types	Frequency of twinning (no. of grains)						Anorthite %
	Albite	Manebach	Pericline*	Albite-ala B	Manebach-ala (akline)	Carlsbad-albite	
Coarse grained grey granites	4	..	..	8	..	..	20–25
Medium grained grey granites	13	..	..	26	..	..	22–28
Fine grained grey granites	8	..	..	10	..	..	22–25
Granodiorites ..	17	..	4	22	..	..	20–28
Gneisses ..	48	..	8	24	..	..	15–28
Amphibolites	4	8	..	4	14	4	28–40
Total ..	94	8	12	94	14	4	Grand Total 226

* Pericline twins are seen across the albite twins. Hence they show albite-pericline (complex) twin laws.

According to Gorai albite-alaB twins are characteristic of igneous rocks and among plutonic rocks the albite-alaB twins show 25 to 49% anorthite. Coulson (1932)[1] also remarks that 33% anorthite is more favourable for the formation of albite-alaB twins.

However, the present study discloses the following features: (*i*) that albite-alaB twins are common in granites and granodiorites; (*ii*) in gneisses, the albite twins predominate; (*iii*) the centre of gravity of the albite-alaB twins is between 22 to 26% of anorthite and its optics are completely sensitive to the variation of chemical composition; and (*iv*) among composition planes (010) is more common than (001) face.

The author is grateful to Prof. M. R. Srinivasa Rao, Department of Geology, Central College, Bangalore, for helpful suggestions.

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NOTE ON THE CEREBRAL GLANDS AND A HITHERTO UNKNOWN CONNECTIVE BODY IN *JONESPELTIS SPLENDIDUS* VERHOEFF (MYRIAPODA, DIPLOPODA)

THOUGH a large amount of work has been done on the neurosecretory system of various invertebrates[1,2] only very little attention seems to have been paid to the group Myriapoda. The only reports appear to be those of Gabe[3,4] and Palm[5] on Chilopods and that of Gabe[6] on diplopods, where besides the brain and the ventral nerve cord the cerebral glands are also reported to be concerned with neurosecretion.

The present study on the neurosecretory system of *Jonespeltis splendidus* Verhoeff, has revealed that, besides the cerebral glands, a pair of hitherto undescribed bodies, which are here termed the Connective bodies, are also concerned with neurosecretion. These are small oval structures measuring 65 μ in length and 45μ in breadth on an average, and are attached to the circumœsophageal connectives

just above the postoral commissure (Fig. 1). These bodies appear distinctly pale bluish in colour in the live condition when examined under the stereoscopic binocular microscope.

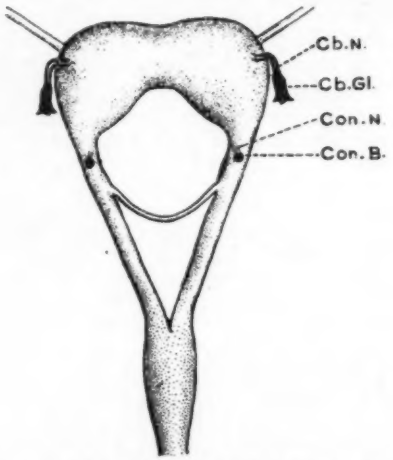

FIG. 1. Diagram of the nerve ring viewed from the dorsal side, showing its relation with cerebral glands and connective bodies, × 45. *Cb. Gl.*, Cerebral Glands; *Cb. N.*, Nerves connecting the cerebral gland with cerebral ganglion; *Con. B.*, Connective Body; *Con. N.*, Connective Nerve.

They are filled with large masses of colloids stainable deep blue-black with Gomori's chrome-alum-hæmatoxylin-phloxine and Heidenhain's hæmatoxylin (Fig. 2). With Heidenhain's Azan the colloids are stained in different shades of red and blue. The cytoplasm of the connective bodies takes the phloxine of the Gomori's stain. The connective bodies are attached to the circumœsophageal connectives by means of a pair of small nerves. Careful examination shows that the colloids come from the neurosecretory cells of the tritocerebral ganglia situated mesially, and are transported along the axons to the connective bodies in which they are stored up. The glands lie closely apposed to the ventral wall of a blood sinus lying behind the brain and it is likely that the product of neurosecretion is discharged into this sinus.

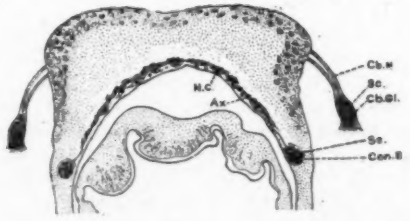

FIG. 2. Diagram showing the axonal transport of neurosecretory material from the tritocerebrum to the connective body, × 100. *Ax.*, Axonic pathway from neurosecretory cell; *Cb. Gl.*, Cerebral Gland; *Cb. N.*, Nerves connecting the cerebral gland with the cerebral ganglion; *Con. B.*, Connective Body; *N.C.*, Neurosecretory cell on the mesial side of the tritocerebrum; *Sc.*, Secretory colloids.

The cerebral glands are about 160 μ in length and 100 μ in breadth; their size and shape vary according to the amount of secretory product they contain. They are connected to the cerebral ganglia by two distinct nerves on each side. The glands contain large phloxinophilic colloids. Colloids could not be traced along the nerves. Gabe[4-6] is of opinion that the cerebral glands also elaborate a secretion. It has not been possible to see this in *Jonespeltis* so far. These glands also lie close to the same blood sinus as do the connective bodies. They are attached to the sinus by digitate processes through which the secretory product seems to be voided into the sinus.

The presence of a sinus close to the cerebral glands as well as to the connective bodies suggests that the mechanism of release of neurosecretory products here is probably similar to that described in insects[7] and crustaceans.[8] Here the connective bodies as well as the cerebral glands are of the nature of storage and release centres and hence could be compared in the functional aspect, to the sinus glands of crustacea.

My thanks are due to the Government of India, for the award of a Research Scholarship, to Dr. K. Bhaskaran Nair for guidance, to Mr. V. Ananthanarayanan for facilities afforded, to Mr. R. Parameswaran for critical examination of the manuscript and to Dr. S. Jones for suggestions regarding identification of the specimen.

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INCIDENCE OF MARINE BORERS IN THE MANGROVES OF THE GODAVARI ESTUARY

WHILE it is well known that submerged wooden structures such as jetty pile, bottoms of boats, etc., in harbours are subject to attack by marine wood-borers, it is not so well known that their depredations extend to growing vegetation in tidal estuaries. The only previous report of a marine borer attacking mangrove is by Roonwal[1,2] who described one species of a Teredinid, *Bactronophorus thoracites* (Gould) infesting mangrove vegetation in the Sundarbans, West Bengal. He further states that "similar mangrove forests in the Malay Peninsula do not appear to suffer in that way as far-as one could judge from published accounts".

Recently we undertook a preliminary survey of the mangrove vegetation in the Godavari Estuary near Yanam to see if the trees are subject to marine borer attack. The mangroves occur not only in the swamps contiguous with the mainland but also in lowly raised islands, at some distance from the shores. The vegetation consists mainly of trees belonging to *Avicennia* sp. (locally known as *mada**) interspersed here and there with grass. At high-tide the roots and the stems of the trees are submerged up to a depth of about one foot. Examination of the dead stumps as well as the stems of living trees revealed that they were severely attacked by both Molluscan and Crustacean borers. The commonest Molluscan borer was *Teredo (Dactyloteredo) juttingæ* Roch, while *Bankia (Bankiella) edmondsoni* Nair was also fairly common. *Bankia (Liliobankia) campanellata* Moll and Roch and *Teredo (Teredo) furcillatus* Miller were represented by a few individuals. Only three specimens of *Martesia striata* (Linn.) were encountered among the borers collected. A good number of the Crustacean borer *Sphæroma terebrans* Bate were also present. Dead stumps were literally honeycombed with the teredinids. Living trees nearer the waters' edge which apparently looked healthy and green, were also severely attacked at the bases, 6 to 8" above and below the ground level. Obviously these would succumb during strong gales.

Our present investigation has shown that the destruction of mangroves by marine borers may actually be much more common and extensive than at present known. We have already encountered as many as five different species of Molluscan borers and a Crustacean borer in the present survey. Detailed investigations on the systematics, ecology and distribution of these borers are in progress.

We are thankful to Dr. R. Nagabhushanam for help in identifying the Molluscan borers.

This work has been carried out with the funds provided by the Forest Research Institute, Dehra Dun, obtained from various sources for the execution of the scheme on "Protection of timber against marine organisms' attack".

Dept. of Zoology, Andhra University, Waltair, *March* 28, 1959.

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M. V. LAKSHMANA RAO.

* A large number of local fishermen are dependent on this vegetation for their firewood.

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SOME OBSERVATIONS ON THE MONOGENETIC TREMATODES FROM THE GILL FILAMENTS OF SOME INDIAN FRESHWATER FISHES

INFECTION from dactylogyrid parasites (Trematoda : Monogenea) is very common among Indian freshwater fishes. Out of 517 specimens of fishes examined by the author during 1952–1957, 170 were found infected. The fishes examined belong to 37 species and 16 piscine families. The results of systematic investigation have been published elsewhere (Jain[1–5]). In this note are recorded some observations on their feeding, locomotion and survival in artificial media. The only other study on locomotion is that of Mizelle,[6] which is confined to North American forms. The fish selected for the present study was *Wallagonia attu* (Bloch.). It has been found to have an infection of 50% and harbours the following four species of parasites : *Haplocleidus gomtius* (0·9–0·96 mm.), *Thaparocleidus wallagonius* (0·85–0·92 mm.), *Mizelleus indicus* (0·58–0·73 mm.) and *Sprostonia wallagonia* (0·55–0·72 mm.).

Dactylogyrids are known to feed on the blood contained in the thin capillaries of the branchial region. There is never an arrangement of cutting plates or any other puncturing apparatus in any form known. There is, however, a specialised apparatus, *haptor*, for adhering on to the tissues. Once the posterior attachment is secured the parasite has free anterior end to search for food. On examining live parasites in a drop of clean water, it was found that the pharynx was always protruded

(Fig. 1). It is probable that the parasites use the suction pump method in obtaining blood which passes out of thin membranous walls of the capillaries.

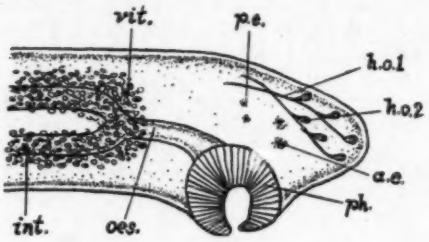

Fig. 1

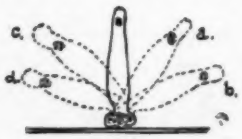

Fig. 2

Fig. 3

Fig. 4

FIG. 1. Diagrammatic sketch of a typical dactylogyrid, seen laterally with protruded pharynx, ventrally. *a.e.*, anterior eye-spots, *h.o.* 1 and 2, head organs 1 and 2, *int.*, intestine *oes.*, oesophagus, *p.e.*, posterior eye-spots, *ph.*, pharynx, *vit.*, vitellaria.

FIG. 2. Diagrammatic sketch of a dactylogyrid 'smelling' for food.

FIGS. 3 and 4. Two methods of a dactylogyrid locomotion presented diagrammatically.

There is some sort of sense of selection of food source possessed by the parasites. The head organs (*h.o.* in Fig. 1) seem to be responsible for 'smelling'. Figure 2 shows a diagrammatic presentation of the 'smelling' behaviour of a parasite, the haptoral attachment remaining fixed. The first position of the parasite is drawn in line while the subsequent positions, *a*, *b*, *c*, *d*, are drawn in dotted lines.

The parasites show two types of wriggling movements. *First*, the parasite adheres firmly by the haptor and then extends the body as far as possible, then fixes itself by pharynx and releases the haptor to come near the anterior end. This process is repeated again. *Second*, the parasite attaches firmly by the haptor, extends the body and fixes the pharynx at a second point, then releases the haptor, body remaining attached to substratum by pharynx, and then attaches it to a third point. The two methods of progression are illustrated in Figs. 3 and 4.

No study seems to have been made before about the period of survival of dactylogyrids in artificial media. In the present study fishes from the morning catch (5 to 6 a.m.) were examined at about 10 a.m. It was surprising that even after 4 to 5 hours of the death of the fish, the parasites were largely found alive. The study of such microscopic parasites was only possible after their release from mucus which took another 5 to 7 minutes. It was observed that the parasites showed slow wriggling movements under a high power binocular microscope for another 10 to 15 minutes. For a more reliable estimate of survival, some parasites were taken afresh from small aquarium fish, *Mystus vittatus* (Bloch.) and examined. It was found that they showed wriggling movements for another 10 to 18 minutes. Thus it appears that the survival in clean freshwater is almost the same whether the fish has been dead for 4 to 5 hours or only 5 minutes.

The observations were made in the Zoology Department, Lucknow University. I am thankful to Professor M. B. Lal for the facilities in the present work.

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LIFE-HISTORY OF *APHIDIUS TESTACEIPES* (CRESSON) AND *PRAON AGUTI* (SMITH) —HYM. BRACONIDAE — PRIMARY PARASITES OF APHIDS, WITH NOTES ON THE EFFECTS OF PARASITISM ON HOSTS

THE braconids, *Aphidius testaceipes* (Cresson) and *Praon aguti* (Smith), parasitize many species of aphids. The life-history of *A. testaceipes* has been studied in detail by several workers.[1,2,4,6,7] Reports on the life-history of *P. aguti* are lacking in the literature.

In the summer, 1954, on the campus of the University of Massachusetts, Amherst, Mass., U.S.A., the author observed a high degree of parasitism by *A. testaceipes* and *P. aguti* among several species of aphids. Along with other detailed studies, data on their life-histories and on the effects of parasitism on the host species were obtained. *Myzus persicæ* Sulz. (Green peach aphid) for *A. testaceipes* and *Macrosiphum rosæ* Linn. (Rose aphid) for *P. aguti* were selected as hosts.

The heavy pupal mortality in the last case (Table I) might be due to the susceptibility of the pupal stage of the two species to those physical conditions which the egg and larval stages could withstand better due to the presence of host body fluids surrounding them. The higher percentage loss of the pupæ of *P. aguti* could probably be due to a still greater degree of exposure to the conditions since, this species, as opposed to *A. testaceipes*, passes the pupal stage outside the dead host or due to the difference in the degree of susceptibility of each parasite species.

TABLE I

Life-history of A. testaceipes *and* P. aguti

Temp. °C.	Relative humidity %	Developmental period (in days) of 30 individuals					
		A. testaceipes			*P. aguti*		
		Egg	Larva	Pupa	Egg	Larva	Pupa
27·6	86	15			15		
29·0	86–68	4		6	4		8
32·0	72	Normal		Failed (56·6% of total pupæ lost)	Normal		Failed (70·0% of total pupae lost)

Effects of Parasitism on Hosts

Aphids struck by either parasite species showed a to-and-fro motion lasting for some time. Renewed attacks produced a marked degree of sluggishness on the hosts and apparently stimulated them to eject copious quantities of exudate through the cornicles. Newborn aphids often succumbed to multiple attacks. Hosts parasitized before they had reached the third instar died prior to maturity. Successful parasitism on hosts that had reached the reproductive stage effected a cessation in their reproduction when the parasite larva reached the third stage and these hosts subsequently stopped feeding. As the parasite larva reached the fourth stage, the digestive and nervous systems of the hosts were attacked and finally the muscular system was also consumed. However, the muscles of the host appendages were left intact, probably due to their inaccessibility to the parasite larva. Very soon the hosts became moribund. The sessile stage of hosts parasitized by *A. testaceipes* or *P. aguti* was reached several hours after their death. Before a host became sessile, the parasite larvæ of both species were seen to make a number of revolutions within the host body. These revolutions were probably more concerned with the ingestion of the host body fluids by the parasite larva than to make the host body spacious for the pupal stage of the parasite.[6]

It is recorded[6] that as soon as the larva of *A. testaceipes* was full grown, the aphid abdomen turned yellow becoming more intense and conspicuous as the host reached the sessile stage. In the present studies, the colour of the parasitized aphids was found to vary with the parasite species, and also in the case of a parasite species, the sessile host colouration varied even within a host species depending upon the food plant of the latter. Thus, the cotton aphid, *Aphis gossypii* Glov., remaining sessile on *Hibiscus* due to parasitization by *A. testaceipes* was much darker than that on squash (*Cucurbita sp.*). Similarly, the rose aphid becoming sessile on rose due to parasitization by *P. aguti* was pearly white in colour. However, the same aphid species becoming sessile on a brown leaf surface was often found rather pale brown in colour, indicating that the colour of the surface also—not necessarily a plant host media—conditioned the sessile stage colouration.

The many valuable suggestions and criticisms offered by Dr. Harvey L. Sweetman, Depart-

ment of Entomology, University of Massachusetts, Amherst, Mass., U.S.A., during the conduct of the above studies, are very much appreciated.

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STAGE OF DEOXYRIBONUCLEIC ACID SYNTHESIS DURING MITOSIS AND MEIOSIS

IT is now well established that of all the chemical constituents of the nucleus so far analysed, the deoxyribonucleic acid (DNA) content is quantitatively the most predictable and consistent. The constancy of its content in nuclei of various plant and animal tissues has its parallel in the constancy of the chromosome number of these cells, and the genetic significance of DNA is hence evident.[1] Data from microspectrophotometric and autoradiographic studies in normal and irradiated plant and animal cells indicate that DNA synthesis and chromosome doubling are synchronous events thereby strengthening the view that an intimate relation exists between chromosome duplication and synthesis of DNA. While the importance of DNA as genetic material is no longer in doubt, there is still some controversy regarding the exact stage and time when DNA duplication takes place during cell division in somatic and gametic cells. Thus, Pasteels and Lison[2] found that DNA synthesis occurs during anaphase and early telophase of mitosis while Alfert and Swift[3] found it to occur during interphase. Similarly, while Swift[4] observed that in microsporocytes of *Tradescantia* DNA synthesis takes place during leptotene, Sparrow *et al.*[5] reported from studies in *Trillium* that DNA content increases till late pachytene or diplotene. On the other hand, in studies in *Lilium* involving the detection of P^{32} incorporation into the DNA fraction of chromosomes by the autoradiographic method, Taylor and McMaster[6] found that DNA synthesis occurs during pre-leptotene, i.e., that part of pre-meiotic interphase which immediately precedes leptotene.

Improvements in cytophotometric techniques such as the use of the two wavelength method introduced by Patau[7] and Ornstein[8] have rendered accurate estimations of DNA content of individual nuclei possible. Using a microspectrophotometer constructed on the two wavelength principle,[9] we studied the DNA content of individual cells during various stages of mitosis and meiosis in *Secale cereale* ($2n = 14$). The results of this study are summarised in Tables I and II (DNA content is expressed in arbitrary units).

From Table I, it will be seen that the DNA value at the resting stage during mitosis was $4{\cdot}75 \pm 0{\cdot}055$. This amount can be referred to as the 2c content corresponding to the $2n$ number of chromosomes. The DNA content increased during interphase and values ranging from 2c to 4c were observed, thus suggesting that DNA synthesis was in progress during this stage. At metaphase, anaphase and telophase, the DNA content remained at the 4c level. The data hence lend further support to the findings recorded earlier by Seshachar,[10] Patau and Swift,[11] Pelc and Howard[12] and many others that during mitosis DNA synthesis is initiated and completed during interphase.

TABLE I

DNA content at various stages of cell division in the root tips of Secale cereale

Stage	No. of measurements	Range	Mean DNA content ± S.E.
Resting ..	17	4·09– 5·13	4·75±0·055
Interphase ..	24	4·68– 9·98	8·22±0·369
Prophase ..	19	8·78–10·23	9·65±0·086
Metaphase ..	16	8·65–10·35	9·56±0·108
Anaphase ..	10	8·99–10·20	9·56±0·123
Telophase ..	10	9·16–10·12	9·67±0·107

The meiotic observations can be grouped into 4 classes (Table II). First, the lowest value

TABLE II

Relative DNA content during microsporogenesis in Secale cereale

Stage	No. of measurements	Range	Mean DNA content ± S.E.
Pre-meiotic ..	10	3·95– 4·93	4·72±0·053
Leptotene ..	19	7·65–10·13	9·23±0·168
Zygotene ..	10	9·23– 9·97	9·47±0·083
Pachytene ..	10	9·36– 9·99	9·60±0·080
Diplotene ..	10	9·13–10·07	9·47±0·090
Diakinesis ..	10	9·34–10·13	9·57±0·099
Microspore ..	15	2·28– 3·13	2·50±0·060

corresponding to 1c content occurred in the microspores. Secondly, the nuclei of cells at pre-meiotic interphase had a DNA content equivalent to the 2c content. Thirdly, the greatest variability in DNA content ranging from 3c to 4c content was observed during leptotene. Fourthly, the DNA value remained constant at the 4c level during zygotene, pachytene, diplotene and diakinesis. From the data, it seems likely that DNA synthesis takes place during leptotene. However, we did not observe typical 2c amounts of DNA in the cells at leptotene studied by us. We had chosen clear leptotene cells for the study and since these had a minimum of 3c DNA content, it is likely that DNA synthesis had started at a stage slightly earlier to leptotene. The finding of Taylor and McMaster[6] that DNA synthesis is initiated during pre-leptotene hence appears to be correct. However, the process of DNA duplication is not completed during pre-leptotene as concluded by these authors but continues during leptotene and ends only before the onset of zygotene. Thus, our data support in part the findings of both Swift[4] and Taylor and McMaster.[6] Mitra[13] has recently presented data showing that in cells of *Lilium longiflorum* irradiated at the pre-meiotic stages prior to pre-leptotene only chromosome type of aberrations were obtained. They persisted in cells treated up to early leptotene but disappeared before the beginning of zygotene. Chromatid breaks, on the other hand, appeared abruptly about mid-pre-leptotene and persisted until diakinesis. From this and our data it seems reasonable to conclude that during meiosis, DNA synthesis (and consequently chromosome duplication) is initiated during pre-leptotene and completed during leptotene.

We are grateful to Dr. B. P. Pal and Dr. A. B. Joshi for their interest in this study. We are deeply indebted to Dr. D. Sen of the Optics Division, National Physical Laboratory, New Delhi, for his help in setting up the microspectrophotometer.

Division of Botany, Indian Agricultural Research Institute, New Delhi-12, *July* 10, 1959.

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IRON-COPPER ANTAGONISM AND GROWTH OF *PIRICULARIA ORYZAE*

THE essentiality of heavy metals, iron, zinc, manganese and to a certain extent copper, for the growth of *Piricularia oryzæ* Cav. has been reported.[1] During the course of further investigations,[2] a close scrutiny of the deficiency yields of the fungus revealed antagonism, additive effects and interaction among these

TABLE I

	Treatments	Mat weight in mg.
1	−all (Purified medium) ..	11
2	+Cu ..	1
3	+Zn ..	7
4	+Zn Cu ..	0
5	+Fe Cu ..	6
6	+all (Fe Zn Cu Mn) ..	153

ions (Table I). The most noticeable toxic effect was that of Cu and to a lesser extent that of Zn on growth and was apparent only in the absence of other essential elements, but if Fe and Mn were also present the toxic effect of Cu and Zn tended to be counteracted. These effects were, however, noticed in heavy metal deficient media where growth was too little to permit definite conclusions. This ionic toxicity of Cu and the interaction of other heavy metals in counteracting the same were, therefore, studied with induced toxicity in an otherwise complete medium by supplying 110 μg. of Cu (per flask of 20 ml. medium) and the Cu toxicity counteracted with the same amounts of Fe, Zn and Mn singly and in all possible combinations when the elements other than those under consideration were always present in optimal doses. It must be emphasized here that these three elements were not toxic to gowth at 110 μg./flask.[2] The various treatments and the results obtained are recorded in Table II.

Table II shows that '+ Cu' (110 μg.) was toxic even in the presence of other elements in optimal amounts though slight growth took

TABLE II

	Treatments	Concentration of trace elements μg /flask*				Mat weight in mg.
		Fe	Zn	Mn	Cu	
1	+all ..	N	N	N	N	153
2	+Cu ..	N	N	N	110	0
3	+Cu Fe ..	110	N	N	110	137
4	+Cu Zn ..	N	110	N	110	0
5	+Cu Mn ..	N	N	110	110	14
6	+Cu Fe Zn ..	110	110	N	110	45
7	+Cu Fe Mn ..	110	N	110	110	49
8	+Cu Zn Mn ..	N	110	110	110	39
9	+Cu Fe Zn Mn ..	110	110	110	110	45

* 'N' denotes optimum level of the metal.

place which could not be assessed quantitatively. If Zn was added to Cu practically no growth occurred indicating the additive effect of Zn on copper toxicity. The addition of 110 μg. of Fe, however, counteracted copper toxicity resulting in almost normal growth of the fungus. Manganese, on the other hand, could not reverse copper toxicity to any appreciable degree. All the two-element (Fe Zn ; Fe Mn ; Zn Mn) and three-element (Fe Zn Mn) combinations (each element added at the rate of 110 μg./flask) supported only a moderate growth of the fungus indicating that the beneficial effect of iron in counteracting copper toxicity is lessened in the presence of Zn and/or Mn. It is thus clear that Fe and, to a much less extent, Mn effectively antagonize copper toxicity. Zinc, on the other hand, appears to exert an additive effect. The presence of Zn or Mn or both reduces the efficacy of iron-copper antagonism indicating the interaction among various elements.

The phenomenon of ion-antagonism in the nutrition of fungi has been shown to exist by many workers.[3-5] However, a definite antagonism between Cu and Fe affecting growth of fungi does not seem to have been reported although this has been noticed in penicillin production by *Penicillium chrysogenum*.[6] The mechanism of Fe-Cu antagonism shown in the present studies remains to be investigated. It is probably very similar to that encountered between Cu and other elements. Discussing the mechanism of toxic action of metal cations on fungi, Horsfall[7] observes that they primarily act at or very near the surface of the cell by replacing the non-toxic cations from the anionic surface sites on the cell wall. It could then be assumed that Fe may act competitively with Cu for the anionic sites on the cell thus reducing the uptake of Cu. That the uptake of Cu by spores of *Monilia fruticola* is depressed in the presence of certain other metallic elements —magnesium, potassium and calcium—has been reported by Marsh.[8]

I am indebted to Professor T. S. Sadasivan, Director, University Botany Laboratory, Madras, for guidance and to Dr. C. V. Subramanian for helpful suggestions.

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A NOTE ON SOME SOUTH INDIAN SPECIES OF THE GENUS *DIOSCOREA*

THE genus *Dioscorea* is fairly well represented in South India growing luxuriantly, especially, in the States of Kerala and Madras. It has always served as a famine food to the tribal peoples. A few species as *D. hispida* are inedible but even these can be rendered edible by observing proper precautions. In the Central Botanical Laboratory a cyto-taxonomic survey of the genus is under progress.

Out of the 16 species reported by Gamble in his *Flora of the Presidency of Madras*, 7 species have already been collected and worked out cytologically by the author.[1] In the present paper two more species, namely, *D. wallichii* and *D. tomentosa* besides another variety, of *D. pentaphylla* not reported previously, have been worked out for the first time.

D. wallichii Hook.f. collected from the hills surrounding Coimbatore is found growing wild. It is a climber twining to the right with the tubers very long and lying deeply buried. It is known in Malayalam as Varakilangu and is edible. The somatic number of the plant examined was found to be $2n = 40$.

D. tomentosa Kœnig. is a climber twining to the left and is a very common species occurring wildly in South India. It has been collected from Coimbatore and Annamalai Hills and is known by a variety of vernacular names as Noolkilangu, Noolvallikilangu, and Chavalkilangu, the names denoting the fibrous

nature of the tubers. Though edible the tribals do not very much value it as an article of food because of the fibres traversing the fleshy portion. The tubers are several, cylindrical, very long and branched, the length of them exceeding a metre and a half. Cytological examination revealed the existence of at least two races with $2n = 40$ and $2n = 60$ chromosomes.

During the course of the present study a large number of plants belonging to *D. pentaphylla* was examined. The tubers of *D. pentaphylla* L. var. *communis* Pr. & Burk. can be readily distinguished from vars. *linnœi* and *jacquemontii* in that the tubers of var. *communis* are short and not elongated to more than twice the diameter. As an article of food var. *linnœi* is always preferred to var. *communis*; in fact the tubers of the latter are invariably avoided because of their nauseous and fibrous nature. Cytological studies of all the tubers revealed the existence of only two races in *D. pentaphylla*. The $2n = 40$ form was confined to var. *linnœi* and *jacquemontii* while var. *communis* always showed $2n = 80$ in somatic counts. Interestingly enough, none of the Indian forms examined so far has revealed $2n = 144$ chromosomes as recorded by Smith[2] for the same Asiatic species.

Besides the above species many plants belonging to the *D. oppositifolia* and *D. hispida* were also collected and studied. Both the species showed only $2n = 40$ chromosomes which is the same as reported by the author in an earlier paper.

Prain and Burkill[3] have recorded that bulbils are never formed in *D. hispida*, *D. wallichii*, *D. tomentosa* and *D. oppositifolia*. The present observations agree with Burkill's findings; however, in *D. hispida* collected from Annamalai and grown at Allahabad, a few bulbils were formed though they were not very well developed.

This survey of South Indian species of *Dioscorea* which is the first to be reported reveals that polyploidy exists in 5 of the species examined so far. The chromosome numbers are summarised as follows:

D. alata L.	$2n = 40$, 60 and 80.
D. esculenta Burkill	$2n = 90$ and 100.
D. bulbifera L.	$2n = 40$, 80 and 100.
D. pentaphylla L.	$2n = 40$ and 80.
D. tomentosa Koenig.	$2n = 40$ and 60.

Sharma and De[4] have worked in some detail two North Indian species of cultivated *Dioscorea* namely, *D. alata* and *D. sativa*, but it is seen that the South Indian forms have different polyploid races besides those recorded by them. In four species as *D. hispida* Dennst., *D. oppositifolia* L., *D. pubera* Bl. and *D. wallichii* Hook.f. the diploid number has been found to be $2n = 40$ only. In the case of *D. belophylla* Voigt. collected by Shri K. S. Srinivasan, Curator, Industrial Section, Indian Museum, Calcutta, the diploid number has been found to be $2n = 80$.

The author is indebted to Dr. K. Subramanyam, Regional Botanist, Southern Circle, Botanical Survey of India, for the facilities afforded in the collection of wild species of *Dioscorea* at Coimbatore and to Dr. S. K. Mukherjee, Keeper, Central National Herbarium, for identification of the herbarium sheets.

Central Bot. Lab., Allahabad, *May* 18, 1959. R. SUNDARA RAGHAVAN.

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PLEUROPNEUMONIA-LIKE ORGANISMS FROM POULTRY IN INDIA

NOCARD and his associates in 1898 studied Pleuropneumonia-like organisms (PPLO) and considered them to be the causative agent of bovine pleuropneumonia. Dienes and Edsall in 1937 recovered PPLO from a suppurating human Bartholin's gland. Since then a number of reports on the isolation of PPLO, either parasitic or saprophytic, mostly from humans, have often appeared.

After Markham and Wong (1952) isolated PPLO from exudates of chickens and turkeys with chronic-respiratory disease (CRD) and indicated that these could be cultivated in cell-free medium, several workers, mostly American, have reported about the occurrence of the avian PPLO.

In India, although there have been indications of the presence of the CRD for some time past, Rao (1958) could not establish the presence of the PPLO in his studies on infectious coryza in chickens.

During the routine post-mortem examination of poultry submitted to this department for the last few years it has been observed that quite a few birds show lesions similar to that

of the so-called CRD. However, the isolation and identification of the PPLO could not be made earlier. Recently attempts made on the lines suggested by Taylor and Fabricant (1957) to isolate PPLO from air-sacs, lungs and trachea of the birds showing such lesions, proved successful.

From tracheal swabs collected from 202 birds, it was possible to isolate PPLO from 188 birds. The biochemical characters studied revealed that the majority of the strains produced acid in glucose and maltose and some in sucrose also. Gas was never produced. Cultures were also made on 20% horse serum agar and the colony characteristics were studied after staining them by the method of Dienes (Adler *et al.*, 1958) (Fig. 1).

Similar studies made on 30 birds of White Leghorn and Rhode Island Red breed on the poultry maintained at Heringhata Farm, Calcutta, revealed the presence of PPLO in 17 birds.

The results presented here are the first reported instance of the isolation of PPLO from poultry in India. Further work is in progress.

The authors are indebted to Sri. P. G. Pande, Director, Indian Veterinary Research Institute, Izatnagar, and Dr. G. I. Wallace, Professor of Bacteriology, University of Illinois, U.S.A., for valuable suggestions, to Dr. S. C. Ray, Milk Commissioner, Government of West Bengal, for his kind permission and facilities provided at the Heringhata Farm, Calcutta, and to Sri. C. V. G. Choudary, Principal, U. P. College of Veterinary Science and Animal Husbandry, Mathura, for providing facilities for the work.

Dept. of Path. & Bact., R. C. PATHAK.
U. P. College of Vet. Sci., C. M. SINGH.
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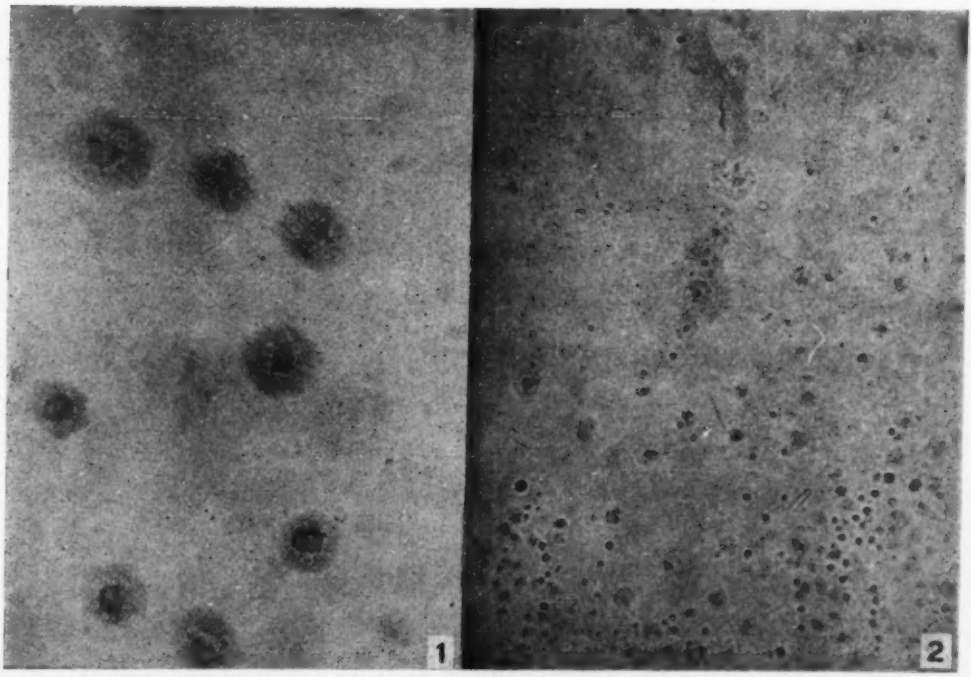

FIG. 1. Two types of colonies of avian pleuropneumonia-like organisms. The colonies on the right are slow growing types after 96 hours of incubation at 37·5 °C on serum agar plates. The colonies on the left are rapidly growing types under similar conditions, × 120.

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DISTRIBUTION OF *PERISTROPHE BICALYCULATA* NEES. IN RELATION TO SOIL NITROGEN AND LIGHT

MISRA[1,2] reported the occurrence of *Peristrophe bicalyculata* Nees. on nitrogen poor soil in the open, and nitrogen rich soil in the shade, and could not reconcile how light compensated for soil nitrogen deficiency in the open for this plant. An estimation of soil nitrate and total plant nitrogen, from collections in light and shade as given in Table I, now reveals that in every locality examined the shade plants are richer in nitrogen. It, therefore, indicates a high nitrogen requirement and utilization by the plant in shade. This observation formed the basis for further experimentation by pot culture and is reported here.

TABLE I

Locality	Nitrate nitrogen in soil (mg./100 g. of soil)		Total nitrogen in plant % (Dry wt. basis)	
	Open	Shade	Open	Shade
Latifshaw ..	2·60	3·40	2·80	3·24
Rajghat ..	2·20	3·00	2·60	3·08
Sarnath ..	2·80	3·80	2·94	4·83
University area ..	2·48	3·75	3·00	3·71
Ramnagar ..	2·75	6·13	3·01	4·91
Akhari ..	2·10	4·10	2·48	3·87

Three sets of five pots were prepared with unmanured garden soil. Set A pots were placed in the open, set B in partial shade and set C in full shade. To four of the pots in each set, were added 0·2, 0·4, 0·6 and 0·8 g. of ammonium nitrate each month, and 100 seeds collected from a uniform population of the species were germinated in each pot. After noting the percentage germination of the seeds, two thrifty and identical seedlings were planted in each case to observe their growth behaviour, and finally the crop in each was harvested after three months' growth, for determination of total plant nitrogen. The data are set in Table II.

There appears to be a reaction between light intensity and soil nitrate as percentage germination increases with higher nitrate in decreased light, whereas nitrate retards germination in high light intensities. Good growth is seen under partial shade especially with higher doses of nitrate. Fully shaded plants show considerably poor growth but there was enhanced assimilation of nitrogen.

The natural distribution of the plant in nitrogen poor soil in the open is, therefore, explainable primarily on account of favourable germination of seeds and subsequent normal growth. However, it seems obvious that the most suitable habitat of the plant is a nitrogen-rich soil under partial shade. It is further seen that the percentage germination is much higher on nitrogen-rich soil in full shade but further growth of the seedling appears negligible presumably on account of deranged nitrogen metabolism. A detailed account of the work will appear elsewhere.

Department of Botany, R. MISRA.
Banaras Hindu Univ. P. S. RAMAKRISHNAN.
Varanasi-5, *April* 2, 1959.

TABLE II

Monthly dosage of ammonium nitrate (g.) added to soil	Set A — Open			Set B — Partial shade			Set C — Full shade		
	% germination	% total N_2 in plant	Growth performance	% germination	% total N_2 in plant	Growth performance	% germination	% total N_2 in plant	Growth performance
0·0	16	2·38	Plants taller, less branched, no flowers and fruits	0	2·33	Poor growth, no flowers and fruits	0	2·87	Poor growth, no flowers and fruits with very few leaves
0·2	16	2·24		16	2·73	Good growth, no flowers and fruits	16	4·27	
0·4	0	2·24	Plants bushy with no flowers and fruits	12	2·75	Best growth, flowering and fruiting	20	4·55	
0·6	0	2·17		8	2·80	Good growth, no flowers and fruits	20	4·55	
0·8	0	1·96		4	2·94	Poor growth, no flowers and fruits	40	4·69	

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REVIEWS

Physics of Meteor Flight in the Atmosphere. By Ernst J. Opik. (*Interscience Tracts on Physics and Astronomy*, No. 6; Interscience Publishers, Inc., New York 1), 1958. Pp. viii + 174. Price: Paper Bound $ 1.95; Hard Bound $ 3·85.

This booklet is mainly a theoretical tract dealing with the many problems associated with the flight of meteors through the upper atmosphere of the earth. The physical approach to the problems consists in predicting the variation of mass, velocity, luminosity, and ionization along the meteor trajectory.

The major part of the book is devoted to collisions, energy transfer, ablation and meteor radiation. The radiation and ablation of meteors take place in proper altitudes prescribed by a kind of 'natural selection' depending on size and velocity.

For the purpose of treating the processes occurring in collisions, meteors are divided into two classes, (i) when the free path of the air molecules is smaller than the linear dimension of the meteor, in which case the collision is preceded by the formation of a hydrodynamic cushion, or air-cap, in front of the meteor, thus impeding the heat transfer, and (ii) when the free path is greater than the radius of the meteor, in which case no air-cap is formed and the impact momentum and energy are transmitted to the nucleus of the meteor by direct hits of the air molecules.

Meteor sizes vary from ·03 to 10 cm. The velocity range of visible meteors is between 20 and 70 km./sec. Micrometeors with radii often between 10^{-3} and 10^{-4} cm. offer a special problem. They are too small to be observed with optical means but, are however, rendered "observable" by their direct impact on receivers sent up in rockets. They form the bulk of the zodiacal-light cloud and their mass per volume of space greatly exceeds that of all other meteors taken together. Entering the atmosphere at a low speed of 12 km./sec. which is only slightly in excess of the escape velocity 11·2 km./sec., they undergo very little evaporation, and are eventually collected from the deep-sea clay as the well-known cosmic spherules.

The author who is well known for his special studies and contributions in meteor theory has encompassed in this little tract a good deal of theoretical as well as practical information which will provide a basis and a background for further research in the physics of meteors.

A. S. G.

Scientific Uses of Earth Satellites. Edited by James A. Van Allen. (The University of Michigan Press, Ann Arbor), 1956. Pp. x + 316. Price $ 10.00.

This volume is a compilation of 33 papers presented by leading scientists in the field of planetary physics, at a meeting of the Upper Atmosphere Rocket Research Panel (U.S.A.) in 1956. These describe the advances that have been so far made and the possible contributions artificial satellites can make to our knowledge of the Universe.

The authors in their respective papers have described the nature of the experiments that are likely to be conducted in the particular field.

The usefulness of an earth satellite in studying the meteorology of the earth is reviewed. A single geiger tube or scintillator carried in the satellite will make possible the study of the cosmic intensity above the atmosphere. The possibilities of exploring the atmosphere with a satellite-borne magnetometer and measurement of earth's magnetic field from a satellite vehicle are discussed in detail. A method for measuring the influx of meteoric particles into earth's atmosphere, based on the detection of the acoustical energy generated upon impacts, is described.

The volume under review presents current thinking of leading scientific experts on satellites and describes rapid advances that were made in the science of artificial earth satellites.

S. B.

Electroanalytical Chemistry. By James J. Lingane. Second Edition. (Interscience Publishers, Inc., New York 1), 1958. Pp. xiv + 669. Price $ 14.50.

The first edition of this book was published in 1953. During the five years the applications of electroanalytical technique have expanded in its different aspects and to cope with this expansion the present edition has been revised and considerably enlarged. The new chapters added are (i) Chapter II on electrical measure-

ments which, though of an elementary nature, makes the book self-sufficient by providing the necessary background for the understanding, by beginners, of the specialised instruments described in individual chapters; (*ii*) Chapter XI on polarographic analysis which was omitted in the first edition for the obvious reason that the author himself, along with I. M. Kolthoff has written a standard and exhaustive monograph on this most fruitful branch of electroanalytical chemistry. In this chapter the essential principles of polarographic analysis are given leaving the details to references in the bibliography. (*iii*) Chapter XII on amperometric titrations and (*iv*) Chapter XXII on chrono-potentiometry which discusses the technique of obtaining and using the potential-time curve for analytical purposes.

The subject of coulometric titration has been dealt with, in the present edition, in two separate chapters, one on instruments and technique, and the other on its many applications. Coulometric titration has two main advantages, *viz.*, that it can more easily be automised than the ordinary volumetric titration, and that it eliminates the need for standard titrant solutions.

Standard potentials of important half-reactions of the elements and their compounds which are very often needed in electroanalytical processes are given in the 13 pages of the Appendix.

This revised and enlarged edition makes the book a comprehensive monograph on the subject and there is no doubt that it will be of great use to graduate students and those who are to be initiated in the special branch of electroanalytical chemistry. The printing and get-up of the book are of the high standard characteristic of Interscience Publications.

A. S. G.

Radioisotopes in the Service of Man. By Fernand Lot. (UNESCO, Place de Fontenoy, Paris-7), 1959. Pp. 82. Price $ 1.00.

The applications of artificial radioactive elements are becoming increasingly wider and often spectacular and the present time may be truly called the era of radioisotopes. In this little book under review which forms the sixteenth in the series of information pamphlets issued by the UNESCO, up-to-date information is given on the various aspects of radioisotopes in the service of man. It traces the discovery of natural and artificial radioactivity, the production of radioactive isotopes and the methods of detecting the radiations given off by them. Then follow chapters on applications of radioisotopes in medicine, industry, science and technology; their use in the improvement of soils, plants and animals and in technical developments, as for example, in metallurgy and petroleum industry.

The discovery of radio cobalt (Co 60) and the comparatively easy method of producing it in atomic piles, has made radiotherapy not a luxury treatment but available at reasonable cost to all who need it. The new technique in the control of radiation from radiocobalt in what is come to be known as the cobalt "bomb" has enabled its use as a source for gamma radiation at a distance, and the cobalt teletherapy apparatus for treatment of various types of tumours is finding increasing use and has become almost a routine equipment in anti-cancer clinics.

The pamphlet is written in simple language is profusely illustrated and provides informative reading.

Metabolic Factors in Cardiac Contractility. By F. N. Furness, M. Selzer and M. M. Gertler, Editors. (New York Academy of Sciences), 1959. Pp. 171. $ 3.75.

This volume which contains a series of papers presented at a conference held on March 18 and 19, 1958, is another tribute to the policy of the New York Academy of Sciences in selecting controversial subjects for their symposia.

The papers are selected on the working hypothesis that "one of the principal and final causes of congestive heart failure is in essence a failure of the available chemical energy to be transformed and utilized as mechanical energy by the heart". This energy is required not only for maintaining the muscular activity of the heart but also for maintenance of intracellular volume since in heart diseases we find that the tissues cannot keep out water and become swollen. The bulk of the papers in this volume, therefore, deals with oxidative phosphorylation associated with carbohydrate metabolism and the physiological effect of ions in regulating cell volume. There is also one paper on the concentration of ions other than sodium and potassium in heart diseases. The papers are presented by clinicians, physiologists, biochemists, biophysicists and physicists so that persons of one discipline can gain from the knowledge of others.

The controversial nature of the problem of the role of energy in the normal working of the heart can be realised from a recent paper (*Nature*, 1959, 183, 997) where it has been shown

that swelling of mitochondria takes place under conditions favourable to oxidative phosphorylation. The authors have, therefore, not drawn any definite conclusions about the actual reasons for congenital heart failure. Nevertheless, a wealth of information has been presented on different aspects of the problem by masters in the field like E. Racker, M. F. Utter, S. Grisolia, T. P. Singer, G. W. E. Plaut, R. J. Podolsky and others. This volume is an important contribution to our knowledge of cardiac contractility.

T. RAMAKRISHNA.

British Medical Bulletin—Haematology, Vol. 15, No. 1. (Published by the Medical Department. The British Council, London, W. 1; India: Oxford University Press), 1959. Pp. 83. Price 20 *sh.*

The application of the newer techniques of chromatography, electrophoresis, immunochemistry, tissue culture and radio isotopes, in elucidating the many, still unsolved problems of hæmatology, has yielded interesting results.

Some aspects of these studies, in this Bulletin, particularly those pertaining to the metabolic studies of the hæmatics, Iron, Folic acid and Vitamin B_{12}; Biosynthesis, chemistry and inheritance of human hæmoglobins; origin and life-history of the cellular constituents of the blood and bone marrow and the hæmatology pathogenesis and treatment of hæmolytis syndromes are highly informative.

The new concept of 'molecular disease' as applicable to hæmoglobinopathies and the chemistry of abnormal hæmoglobins has given valuable insight into the action of genes and the fine control exercised by them. The lucid presentation of this theme has definitely enhanced the value of this volume to all research workers engaged in the study of the pathogenesis of diseases in general and blood dyscrazias in particular.

M. SIRSI.

Endocrine Control in Crustaceans. (*Cambridge Monographs in Experimental Biology.* No. 10.) By D. B. Carlisle and Sir Francis Knowles. (Cambridge University Press, London.) Pp. 120. Price 21 *sh.*

Although the terms 'internal secretions' and 'chemical messengers' had been introduced to physiology in the XIX century by Claude Bernard, and Brown-Sequard and d' Arsonval respectively, the concept of a chemical co-ordination of functions in the animal body was developed much later (1904) by Bayliss and Starling, in whose laboratory the name 'hormone' was invented, and the first recognisable hormone, *secretin*, was discovered. Ever since, the study of vertebrate hormones has made phenomenal progress, but there was no clear proof of the existence of a hormone in invertebrates until 1928, when Koller showed that the contraction of the chromatophores of the shrimp is caused by a substance in its eye stalk. Thus, invertebrate endocrinology, in particular crustacean endocrinology, started.

The book under review is an authoritative and accurate account of the progress of crustacean endocrinology during the last thirty years, written by authors, who themselves have made very significant contributions to the development of the subject.

Crustacean endocrinology, as described in this book, shows three phases of development. During the first phase (1929-39), the presence of chromactivating hormones was demonstrated and the sinus gland was suggested as the source of these substances. During the second phase (1939-50) it was shown that there were several distinct chromactivating substances and that various aspects of metabolism, growth and development were under hormonal control. It was during this phase that suspicion also arose that the sources of hormones were within the nervous system. During the third phase of crustacean endocrinology (1951—) it has been shown that the endocrine systems in Crustacea are neurosecretory, and that the hormones are produced in modified neurones and transferred along the axons to the sites of release into the blood.

What about the future lines of investigation? The unravelling of the structure of the neurosecretory cells under the electron microscope and the biochemistry of their hormones will be the main lines. These lines have been already started, and it has been shown that the chromactivating hormones are peptide in nature, whereas the ovary-inhibiting hormone is a steroidal substance. Then there are also the lower crustacea to be investigated. Further progress in crustacean endocrinology may be expected to throw some light on the significance of neurosecreting mechanisms in the animal kingdom and also on the comparative evolution of the nervous and chemical co-ordinating mechanisms.

The book is written with scientific insight and includes over 250 original references. It will be useful not only to students of crustacean endocrinology but to all interested in a physiological approach in biology.

The format of the book is good, and the illustrations, which are clear and instructive, add to the scientific value of the book.

R. V. SESHAIYA.

Mechanical Cultivation in India. By Dr. D. A. Gadkary. (The Manager, Publications, Civil Lines, Delhi), 1957. Pp. vii + 147. Price Rs. 7·25.

This is a monograph published by the Indian Council of Agricultural Research with a Foreword by the Minister of Food & Agriculture and a Preface by the Vice-President of the Council. The book contains all the information collected from various States on subjects, like the scope for mechanical cultivation in the country, farm machinery and its use in different areas, maintenance of machinery and organisational problems. The subject-matter is divided into four chapters with an extensive set of appendices and a short bibliography.

Mechanisation in its wide sense is usually taken to include not only power-driven equipment like tractors, but also improved agricultural implements worked by hand and bullock power. The present publication, however, deals only with the former. Mechanisation for particular types of work is now accepted as an essential element in increasing crop production in the country. It is also accepted that mechanical cultivation would be feasible only if farmers group themselves into co-operative societies and have a central pool of machines for cultivation.

The limitations and the scope for mechanical cultivation is sufficiently explained in Chapter I. Some idea has also been given of the minimum acreage that would be required for the economic employment of tractors. There is enough evidence to show that conducting agricultural operations with power-driven machines has by itself no advantage in respect of yield though it does give a better tillage and more uniform depth of ploughing. The main feature, however, is that the use of tractor enables agricultural operations to be conducted in a more timely manner. There is also no conclusive data to show that the cost of agricultural operations per acre by tractors is cheaper than cultivation by bullocks. But with large holdings, a combination of tractors and bullocks might become more economical.

Various farm machinery and power-driven implements, like ploughs, harrows, drills, harvesters, etc., are described in Chapter II and the functions of different implements are also given. In Chapter III which deals with the selection and maintenance of equipment, the conditions under which the different types of tractors that should be used and the functions and detailed structure of different machines is given. The organisational aspects are described in great detail in Chapter IV. This chapter deals with the ideal set up of the organisation, how the organisation should be split up into units and the details of the equipment necessary for each unit. Information is also provided of the staff required, methods of collecting data and utilising such data.

While points that should be taken into consideration in selecting a suitable machine are discussed, it is still unrealistic to expect Indian farmers to do the testing before final choice is made of the particular type required. This has to be done only by the Government department and although information on the suitability of machines for particular types of work is already available, as for instance work involved in soil conservation, it cannot be said that we have still data to recommend to the farmers as to what particular type of machine he should purchase with reference to his soil and cropping conditions. The book can be of great value to technicians rather than to farmers.

K. R.

British Medical Bulletin—Causation of Cancer. Vol. 14, No. 2. (Medical Department, the British Council, 65, Davies Street, London W. 1), May 1958. Pp. 73-196. Price 25 *sh.*

This special number comprises of 21 papers by 27 leading research workers of Great Britain and the Commonwealth. The subject-matter may be broadly divided under four headings: (i) Chemical Carcinogenesis, (ii) Occupational Carcinogenesis, (iii) Radiation Carcinogenesis and (iv) The Dynamic Aspects of Carcinogenesis.

(i) *Chemical Carcinogenesis.*—Prof. A. Haddow in his introduction has first outlined general progress of work on the causation of cancer during last eleven years and then authoritatively surveyed the subject of chemical carcinogenesis of hydrocarbons, azo compounds and aromatic amines. Although the field of cancer in general is too full with theories and working hypothesis, Prof. Haddow's critical appraisal of some of the current concepts of carcinogenesis facilitates much clearer understanding of the problem.

Dr. Boyland has critically examined biological aspect of carcinogen testing.

Dr. Orr in his short paper on irreversible changes in chemical carcinogenesis has presented his views on the latent period in chemical induction of skin cancer. Salaman has reviewed work on co-carcinogenesis since 1947 and has discussed the present position of the multistep theory. Peacock, himself an active investigator in the field of avian carcinogenesis, has traced the development of our knowledge in this field since the first successful experimental induction of sarcoma by Rous in 1911.

Bielschowsky and Horning have carefully discussed the mechanism of carcinogenesis in various tumours of endocrine organs as pituitary, ovary, adrenal, testes, etc., as well as in the disease of other tissues as kidney, bone, liver, leukæmia, etc., indirectly controlled by hormonal imbalance.

(ii) *Occupational Carcinogenesis.*—In occupational carcinogenesis exogenous factors responsible for the causation of lung cancer have been reviewed by Kennaway and Lindsey. This paper covers chemical investigations on tobacco, tobacco smoke and town air in relation to the incidence of cancer of the lung and respiratory tract. Lately mineral oil carcinogenesis and azo compounds and aromatic amines of dyestuff industry have been attracting considerable attention and this has been covered by Cook, Carruthers and Woodhouse and also by Walpole and Williams.

(iii) *Radiation Carcinogenesis.*—In radiation carcinogenesis, valuable data of Court-Brown on incidence of leukæmia among the survivors of atomic explosions and on patients irradiated for diagnostic or therapeutic purposes should be of great interest, because of increasing awareness of radiation hazards. Glucksman reports the yield of skin tumours induced by irradiation in varying doses and compares them with carcinogen induced skin tumour and its induction period. The work of Doniach in experimental induction of thyroid tumours can be applied to that of hyperthyroid patients treated with I^{131} and role of pituitary for the secretion of thyroid-stimulating-hormone (TSH) is further stressed.

(iv) *Dynamic Aspects of Carcinogenesis.*—Dynamic aspects of chemical carcinogenesis in relation to metabolism and excretion of carcinogens, their growth inhibiting and enzyme inhibiting action and tissue metabolism are discussed by Elson.

Prof. Green has elaborated his concept of immunological basis of carcinogenesis in the light of relevant literature. The origin of this theory is in the tumour-inhibiting (TI) action of carcinogenic polycyclic hydrocarbons on some transplantable tumours. The hypothesis of protein binding nature of carcinogen—confirmed by several other workers—is taken as the basis and this binding is presumed to change protein complexes of the cell and with it a certain degree of isoantigenic loss, because of which the new race of cells does not recognize growth-regulating mechanism—the condition ultimately leading to uncontrolled neoplastic growth. The hypothesis now appears much more acceptable and thought-provoking.

The material on various aspects of 'Causation of Cancer' so neatly arranged, is a valuable reading for every worker in the field of Cancer Research, for proper understanding of the newer concepts of the problem of carcinogenesis.

KAMAL J. RANADIVE.

Books Received

Nuclear Reactor Physics—A Practical Text and Guide for Design Analysis of Nuclear Reactors. By R. L. Murray. (Macmillan & Co., London W.C. 2), 1959. Pp. xi + 317. Price 30 *sh.*

Differential Thermal Analysis as Applied to Building Science. By V. S. Ramachandran and S. P. Garg. (Central Building Research Institute, Roorkee). Pp. vii + 182.

Fallacies in Mathematics. By E. A. Maxwell. (Cambridge University Press, London N.W. 1), 1959. Pp. 95. Price 13 *sh.* 6 d.

Modern Fishing Gear of the World. By H. Kristjonsson. (Fishing News Books Ltd., 110, Fleet Street, London E.C. 4), 1959. Pp. xxxi + 607.

Synthesis of β–Amino, α β–Unsaturated and Bis-(Aminoaryl) Sulphones. By M. Balasubramanian. (The Registrar, Annamalai University, Annamalainagar). Pp. iv + 89.

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SCIENCE NOTES AND NEWS

The Green Bee Eater as Predator of the Desert Locust

Shri Charan Singh (Locust Warning Officer Churu, Rajasthan) writes that he often observed the Green Bee Eater (*Merops orientalis*, Latham.) feeding on adults and hoppers of the desert locust (*Schistocerca gregaria*, Forsk.)in Bikaner and Sri Ganganagar districts of Rajasthan from 1953-56. On the 20th August 1958 during the course of locust survey it was observed at Rajasar Village of Churu District that a Green Bee Eater followed an individual of the desert locust adult high in the sky upto the height of 800 feet with great agility and returned to its perch with prey which was devoured. The object of this note is to record an important predator of the desert locust, in Rajasthan, in addition to the birds listed by Husain and Bhalla (1931).

Control of Fruit Drop in Mango

Messrs. K. Kirpal Singh, Sucha Singh and Krishna Lal Chadha report from Panjab that fruit drop in mango could be controlled by spray treatment with the plant growth regulators alphanaphthaleneacetic acid (NAA) and 2, 4-dichlorophenoxy-acetic acid (2, 4–D). The treatments were tried on Fajri mangoes on May 15, six weeks after full bloom. NAA at 30 and 40 p.p.m. in water gave the best control of fruit drop registering only 22% fruit-fall between May 15 and July 18 as compared with 52% in control during the same period. Application of 2, 4-D at 10 p.p.m. gave a fruit drop of about 28% and further increase in its concentration showed no better control.

Both the growth substances influenced fruit quality by increasing fruit size, titratable acidity and ascorbic acid content, and suppressed to a great extent, the oozing out of sap from the pedicel which commonly blemished the surface of untreated fruits. Some treated fruits also exhibited a red blush on yellow ground near maturity as against the normal green colouration of the ripe fruit in this variety.

Fifth Congress on Theoretical and Applied Mechanics

The above Congress will be held under the Presidentship of Dr. A. N. Khosla, Vice-Chancellor, University of Roorkee, from December 23 to 26, 1959, at the University of Roorkee, Roorkee.

Research Papers may be contributed on any of the following topics: (1) Elasticity—Plasticity—Rheology, (2) Fluid Mechanics, (3) Mechanics of Solids, (4) Statistical Mechanics—Thermodynamics—Heat Transfer, (5) Mathematics of Physics, Statistics and Computation, (6) Experimental Techniques, and should reach the Secretary-Treasurer with three copies of their abstracts before October 15, 1959.

There will be invited addresses of one-half hour each on special topics. The Registration Fee for the Congress is Rs. 10·00 which should be sent to the Secretary-Treasurer at Kharagpur.

The Congress will be preceded by a Symposium on 'Non-linear Physical Problems' under the joint sponsorship of the Indian Society of Theoretical and Applied Mechanics and UNESCO, on December 21 and 22, 1959. Invitations are being extended to foreign and Indian participants.

Application Forms for registration and any other information may be obtained from the Secretary-Treasurer, Dr. B. R. Seth, Indian Institute of Technology, Kharagpur.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Shri H. S. Rama Rao for his thesis entitled "Ultrasonic Studies in Liquid Media", the D.Sc. Degree in Botany to Smt. H. Maheswari Devi for her thesis entitled "Embryological Studies in Compositæ and Gentianales" and the D.Sc. Degree in Geology to Shri B. B. G. Sarma for his thesis entitled "Studies on Depositional Environments of Some Sedimentary Formations".

Osmania University has awarded the Ph.D. Degree in Chemical Technology to Shri B. V. S. Subba Rao for his thesis entitled "Studies on Thermal Decomposition of Limestones" and the Ph.D. Degree in Chemistry to Shri R. Kurdukar for his thesis entitled "Search for New Insecticides: Synthesis of Some Substituted Xanthones, etc."

The University of Madras has awarded the Ph.D. Degree in Chemistry to Miss Roshan J. Irani for her thesis "Carbohydrate Constituents and Sugar Metabolism of *penicillium chrysogenum*". Miss Irani worked under Dr. K. Ganapathi in the Hindustan Antibiotics, Pimpri.

Weather Balloon Altitude Record

An experimental weather balloon of the U.S. Army, launched on February 11, 1959, reached a height of 1,46,000 ft (about 28 miles). The balloon was made of a new synthetic neoprene compound resistant to tears, extreme temperatures and the intense sunlight. During the flight which took two hours the balloon expanded from a diameter of 10 ft. to one of 65 ft. It carried a radio-equipped package containing weather instruments and a special type of altitude meter. The instruments recorded a low temperature of — 85° F. at an altitude of 10 miles. At higher altitudes, the radio signals revealed a warming trend reaching 45° F. at the record height.—[*Bull. Am. Met. Soc.*, 1959, **40** (5), 262].

Vanguard I Photographed

The Smithsonian Optical Tracking Station at Woomera, Australia, has successfully photographed the Vanguard I earth satellite at the apogee of its orbit, nearly 2,500 miles from the earth. No other object as small as this 6-inch sphere has been photographed from such a distance.

Infra-red Hygrometer

The infra-red hygrometer, the method of measuring humidity by absorption spectra analysis, has been developed to the point where it now offers attractive possibilities to the meteorologist in special problems where conventional methods prove inadequate and higher cost of instrumentation will be justified.

R. C. Wood describes in *Bull. Amer. Met. Soc.*, June 1959, a relatively uncomplicated instrument in which the energy attenuation in the 2·6 μ water band is related to the concentration of water vapour in the sensing path. The assembly consists of a source of infra-red radiation, a means for isolating selected wavelengths of radiation, the sensing path or absorbing column containing the atmospheric sample, and a radiation detector. Some areas of application for this technique are Micro-meteorology, Arctic meteorology and upper air meteorology which present special difficulties in the use of conventional methods.

Photographing the Sun by Ionized Helium Light

In March, the U.S. Naval Research Laboratory used a rocket to photograph the Sun's hydrogen atmosphere in ultra-violet light. The same group, led by Dr. Herbert Friedman, now plans to photograph the Sun's helium atmosphere—at even shorter ultra-violet wavelength. This component of the solar "weather" lies farther out from the Sun's visible disc, where the outer layer of the chromosphere merges with the inner layer of the corona. From the photographs at various wavelengths, there is emerging a picture of increasing gas turbulence and rising temperature at increasing heights above the surface.

The March photograph by hydrogen light (Lyman-alpha line) showed a strikingly stormy Sun. If this pattern persists there should be bright emission from ionized helium, even though helium needs a temperature of 20,000–30,000° C. to ionize, compared with 6,000–10,000° C. for hydrogen. There is a practical side to this work: rays emitted from the Sun's ionized helium may be responsible for creating the upper region of the Earth's ionosphere, and it may become possible to plot the solar weather and predict terrestrial effects such as short-wave radio "black-outs".

Non-magnetic Alloy for Instrumentation in Magnetic Fields

Measurements made in the presence of magnetic fields frequently require portions of the measuring apparatus to be fabricated from nonmagnetic materials; such pieces, for example, as balance arms, sample holders, Dewar walls to be used between the poles, torsion fibres and galvanometer suspensions. These items are made of non-ferromagnetic materials such as copper, brass, silver, aluminium, lucite or quartz. Occasionally the small effects due to ferromagnetic impurities or even the intrinsic paramagnetic or diamagnetic moment of these materials become a problem.

A high-purity copper-nickel alloy of composition 96·3% copper and 3·7% nickel by weight, fabricated from copper rated 99·999% pure and nickel rated 99·997% pure, has been found to be completely non-magnetic. Experimental tests show the alloy to have zero magnetic moment at room temperature and less than a tenth of the magnetic moment of pure copper at all temperatures down to 2° K. The susceptibility of this alloy is found to be field independent from 0 to 24,000 œrsteds. A method of preparing the alloy is described by E. W. Pugh in the *Rev. Sc. Inst.*, **29** (12), 1118.

Research on Radiation Effects on Bacteria

A research project to study the effects of radiation on bacteria has been sanctioned by the International Atomic Energy Agency. The object of this research is to contribute

to an understanding of the reasons why micro-organisms vary widely in their sensitivity to ionizing radiation and to examine how their radio-sensitivity can be increased. Such an understanding would be of value in the study of some fundamental problems of radio-biology and radiation protection. In the matter of preservation of food by irradiation, it is known that many bacteria posses a high level of resistance to ionizing radiation requiring for their destruction dosages which may prove harmful for the food itself. The problem will be to find a method to increase the radio-sensitivity of bacteria by some artificial means before they are subjected to radiation, so that a low radiation dose may prove completely effective and safe.

Dr. Peter Alexander of the Chester Beatty Research Institute, London, will guide this project in collaboration with the Microbiology Department of the Imperial College of Science and Technology in Kensington.

Chlorophyll from Nettles

The Forest Research Institute, Dehra Dun, in the Himalayan foothills, has developed a process for extracting chlorophyll as a copper derivative from the stinging nettles which grow in abundance in the temperate Himalayan tracks. Dried leaves of the plant, powdered finely, are extracted with ethyl alcohol after infusion with a solution of copper sulphate. The extract is concentrated in an acidic solution and refluxed in the presence of a suitable copper salt. The copper chlorophyll separates out from the solution and is eluted with hot water and purified.

Moon Relay Station

Using the moon as a passive relay station radio communication link was successfully established between U.K. and U.S. across the Atlantic in a series of experiments carried out between May 11 and May 14, 1959. The transmitting station was Jodrell Bank (U.K.) and the receiving station was the Air Force Cambridge Research Centre, Mass (U.S.). A 1-kW. FM transmitter working on 201 Mc./s. was used with the 250 ft. steerable radio telescope of Jodrell Bank. At the receiving end in U.S., the 84 ft. radio telescope was used with receivers of various bandwidths from $\pm 2{\cdot}5$ to ± 10 kc./s. Similar receivers were also used on the telescope at Jodrell Bank for monitoring the local lunar returns.

Experiments lasting for about 40 hr. included transmission of audio tones up to 15 kc./s. and of messages by slow Morse, tests of intelligibility of speech and quality of music.

A number of major advantages may be expected from this lunar link system. Unlike conventional radio channels, this method will not be impaired by noise interference and blackouts caused by disturbances in the ionosphere. In addition, the new system opens up a whole new spectrum of frequencies in the already overcrowded radio channels for long range communication. The commercial interest in this field will no doubt stimulate further developments.

Marine Bacteria and Deuterium Concentration in Sea Water

In the course of studies of the calcium carbonate deposits of the Bahama Banks, conducted by the U.S. Geological Survey, there was a chance discovery of a marine bacterium which produced hydrogen gas. The bacterium which occurred in high concentration within the superficial sedimentary layer was isolated and cultured using the sea-water dextrose as substrate. Mass spectrometric analysis of the gas generated by this micro-organism revealed an unexpectedly high percentage of light hydrogen (protium) and an apparent absence of the normal isotope, deuterium, in the gas mixture. Subsequent analysis of the sea-water dextrose substrate showed the normal distribution of the protium-deuterium isotopes. It was apparent that the deuterium in the medium was being selectively fractionated by the cellular biochemical processes.

An understanding of these processes involved in separation and concentration of deuterium may have economic importance, as for instance in the production of heavy water. Of academic interest is the possible significance of the role of marine bacteria in the concentration of heavy water in the seas during past geologic time. Today, sea-water contains from 10 to 25% more D_2O than fresh water, the atmosphere, ice, and igneous rock.—*Science*, 1959, 129, 1288.

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